PRELIMINARY ENGINEERING REPORT

City of Memphis, TN

Stiles WWTP

September 2014

CDM Smith

Table of Contents

List of Figures

List of Tables

Appendices

Section 1
Introduction

The City of Memphis (City) has contracted with CDM Smith to support the investigation of disinfection options for the Stiles Wastewater Treatment Plant (WWTP). Based on results of pilot testing as reported in the *NPDES Disinfection Study Project Stiles WWTP Pilot Testing Report* (Pilot Report) (CDM Smith, 2013), CDM Smith has recommended the use of peracetic acid (PAA) because it is both the lowest cost option as well as the best system to implement from an operational standpoint. Based upon the findings of the alternatives analysis and the pilot testing results, the City is proceeding with preliminary and final design of a full-scale PAA disinfection system. This preliminary engineering report (PER) provides a description of the preliminary design of the PAA system including initial equipment sizing, PAA system operations, instrumentation and control, and updated opinion of probable construction cost.

At the time of preparation of this PER, it is the intent of the City of Memphis to lease the chemical feed, storage and delivery system from the PAA supplier as part of the chemical purchase agreement. Thus, CDM Smith has coordinated with FMC Industries as a potential provider in obtaining process equipment sizing and recommendations on the PAA feed system presented in this report.

The selection for the PAA provider could either be direct negotiated or competitively bid. When the City selects the PAA provider, this information should be updated with the specific details of the selected supplier's system. Selection of the PAA supplier is recommended to be completed early in the design and prior to final design and overall project bidding. This will allow for the final equipment sizing and placement to be included in the final bid package for general contractors and will provide the competitive pre-selection process.

Section 2

Description of Stiles Wastewater Treatment Plant

Wastewater treatment at the Stiles Wastewater Treatment Plant (WWTP) is based on a contact-stabilization process. Wastewater entering the facility flows through coarse and fine bar screens and grit tanks for removal of large organic and inorganic constituents in the raw wastewater. The biological treatment process occurs through a series of tanks that provides both contact time to allow biomass to uptake biochemical oxygen demand (BOD), and stabilization which allows the biomass to degrade the adsorbed wastewater organic constituents. The biological treatment process is followed by secondary clarification prior to discharge in the Mississippi River. Waste activated sludge (WAS) is sent to a covered lagoon system for anaerobic digestion. The digested sludge is dewatered with belt filter presses and the dewatered sludge cake is stored in a surface disposal facility on-site. The biogas generated by the covered lagoon system is sold to a nearby industry and used to fuel an electric generation on-site. A process flow diagram for the WWTP is provided in **Figure 2-1**.

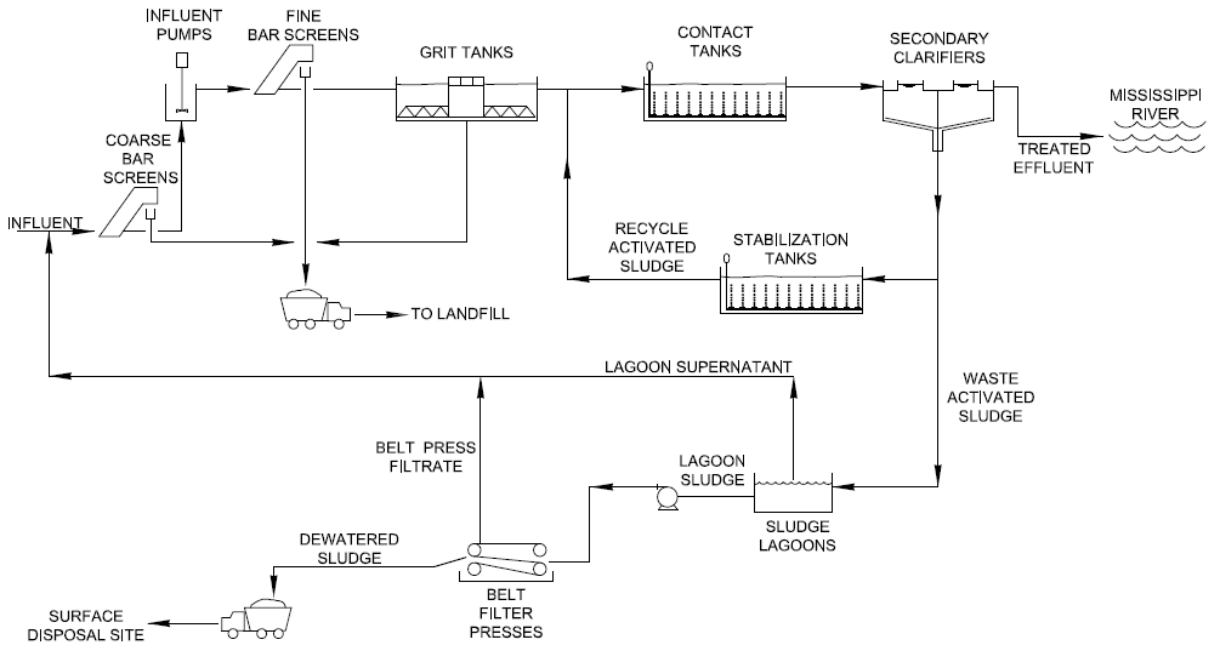


Figure 2-1 Process Flow Diagram of Stiles WWTP

2.1 Design Flow

The Stiles WWTP has a treatment design capacity of 135 MGD with a hydraulic capacity of approximately 250 MGD. These flows serve as the basis of design for the disinfection system. Flow measurement at the Stiles WWTP is currently obtained at the head of the plant prior to treatment.

2.2 NPDES Permit Requirements

The Stiles WWTP NPDES permit, number TN TN0020711, issued by Tennessee Department of Environment and Conservation (TDEC) authorizes the facility to discharge treated effluent from

Outfall 001 to the Mississippi River at Mile 738.3 pursuant to the permit limits and monitoring requirements specified in the permit. The effluent limits for parameters relevant to the evaluation of disinfection processes are summarized in **Table 2-1**. Insufficient data is available to discuss each parameter's impact on PAA dosing; however, a strong relationship between color and oxidant demand was observed throughout the pilot study with higher color having a higher chemical demand.

Table 2-1 Effluent Water Quality Characteristics at the Stiles WWTP

Parameter	Daily Performance Data			New Draft NPDES Limit		
	Minimum observed	Average or mean1	Maximum observed	Daily (minimum and maximum)	Weekly maximum	Monthly maximum
Daily Flow (MGD)[2]	58	94	232	135	-	-
BOD (mg/L)[3]	5	34	144	86.1	64.7	43.1
TSS (mg/L)[3]	1	22	103	104	78	52
pH[4]	6.5	7.2	8.1	6.0 – 9.0	-	-
E. coli (cfu/100mL)[5]	1.3×10^4	6.0×10^5 (4.4×10^5 as geomean)	1.1×10^7 (1.8×10^6 is 99-percentile)	487	-	126 (geomean)
Apparent Color (PtCo units)[6]	29	749	2084	-	-	-
True Color (PtCo units)[7]	24	619	2000	-	-	-
Apparent UVT (%)[8]	0 (1.0)[9]	9.3	36	-	-	-
Filtered UVT (%)[10]	0.6 (2.0)[11]	16	71.9	-	-	-

Notes:
[1]Arithmetic means were reported for all values except E. coli which is also reported as a geometric mean
[2]Average daily influent flow values; period of record = 9/1/09-5/31/2013
[3]Daily values taken from composite effluent samples; period of record = = 9/1/09-5/31/2013
[4]Daily values taken from and grab effluent samples; period of record = 9/1/09-12/31/2012
[5] Daily values taken from and grab effluent samples; period of record = 1/17/08-7/11/2013
[6]Daily values taken from composite effluent samples; period of record = 8/11/2011-5/21/2013
[7]Daily values taken from composite effluent samples; period of record = 8/11/2011-5/21/2013
[8]Daily values taken from composite effluent samples; period of record = 8/11/2011-5/21/2013
[9]In parentheses: lowest 10th percentile of apparent UVT data on record as noted in comment 8
[10]Daily values taken from composite effluent samples; period of record = 8/11/2011-5/21/2013
[11]In parentheses: lowest 10th percentile of filtered UVT data on record as noted in comment 10
[12]The NPDES Permit value for flow is shown as a "permitted average capacity" and not as a limit

In addition to the discharge limits outlined in Table 2-1, TDEC may require additional investigations to characterize and control chlorinated DBPs, if chlorination is chosen as the preferred disinfection method. In the permit for the Stiles WWTP, Section 3.6.1., ***Additional Permittee Submittals (If Chlorination Disinfection System Selected)***, indicates that the Permittee must provide the division with the types/amounts of specific chlorinated byproducts species to be in the Outfall 001 treated effluent and how newly generated byproducts are related to TRC according to the compliance schedule provided in the permit.

Further, TDEC water quality criteria for the receiving reach of the Mississippi River include standards for DBPs. The designated uses of the receiving reach of the Mississippi River in Tennessee are: Industrial Water Supply, Fish and Aquatic Life, Recreation, Livestock Watering and Wildlife, Irrigation and Navigation. The general water quality criteria for these designated uses are provided in the Rules

of the TDEC Tennessee Water Quality Control Board Division of Water Pollution Control, Tennessee Code Annotated (TCA) Chapter 1200-04-03.

The Fish and Aquatic Life and Recreation use in-stream water quality criteria contain parameters that are relevant to chlorine disinfection as summarized in **Tables 2-2** and **2-3**. These parameters provide the basis of the analytical testing of DBP formation. Criteria for Industrial Water Supply, Livestock Watering and Wildlife, Irrigation, and Navigation designated uses are narrative and do not contain additional specific chemical constituents of concern to disinfection.

Table 2-2 Analytical Parameters based on TDEC Numeric Criteria for Fish and Aquatic Life

Compound	Criterion Maximum Concentration (CMC) (µg/L)	Criterion Continuous Concentration (CCC) (µg/L)
Total Residual Chlorine (TRC)	19	11

Table 2-3 Analytical Parameters based on TDEC Numeric Criteria for Recreation

Compound		Organisms Only Criteria[1] (µg/L)
Dioxin[2]		0.000001
Trihalomethanes (THMs)	Bromoform	1400
	Chlorodibromomethane	130
	Chloroform	4700
	Dichlorobromomethane	170
N-Nitrosodimethylamine (NDMA)		33

Notes:
[1] "Organisms Only" Criteria for Recreation refers to the protection of public health due to the consumption of organisms. Different criteria exist where the water impacts both the consumption of water and organisms, i.e. where the water is designated for both recreation and domestic water supply.
[2] Total dioxin is the sum of all dioxin and dibenzofuran isomers after multiplication by Toxic Equivalent Factors (TEFs)

Section 3

Peracetic Acid Bulk Disinfection

Disinfection, by bulk liquid PAA is relatively new method of municipal wastewater disinfection in the United States (US). This method of disinfection is gaining interest in the US due to its ability to provide bacterial inactivation performance at costs competitive to other mature technologies without the concerns regarding formation of regulated DBPs. PAA has been applied to the food, beverage, medical and pharmaceutical industries as a disinfectant for many years and has been demonstrated for municipal wastewater disinfectant in Europe with PAA disinfection being applied for effluent reuse (with an E. coli limit of 10 cfu/100mL) at the largest WWTP in Milan, Italy (Nosedo WWTP with an average flow of 110 mgd) since 2006.

PAA is generally supplied as an equilibrium mixture of PAA, hydrogen peroxide, acetic acid and water. It is recommended that PAA be stored in passivated (nitric acid) stainless steel or high density polyethylene. A material data and safety sheet (MSDS) for 15-percent solution PAA is included in **Appendix A** for reference. The MSDS provides a summary of storage and handling recommendations, health impacts, physical and chemical properties, toxicological and ecological data, disposal and regulatory information. PAA may be stored at least 9 months with significant degradation so no special provisions are recommended for storage or chemical turnover.

A pilot test using PAA disinfection was conducted at the Stiles WWTP between February 2013 and April 2013. The results of the PAA pilot have been used to develop the design parameters presented in this report.

3.1 PAA Disinfection Dose Recommendations

In order to establish the dose basis of design for PAA which will be used to develop the average, minimum and maximum chemical feed rates, it is necessary to determine the range of PAA doses that provide the required bacteria inactivation rates. To determine the chemical dose that would need to be applied to achieve the target disinfection rates, the target residual of 0.4 mg/L was determined using the model developed in the *NPDES Disinfection Study Project Stiles WWTP Pilot Testing Report* (CDM Smith, 2013). Because the target residual concentration required for disinfection is less than 2.0 mg/L, quenching (the equivalent of dechlorination for chlorine) would not be required under the current draft permit.

Although a very low residual was shown to provide disinfection under both average and peak flow conditions, there is a chemical oxidant demand that must be satisfied before a residual will be present. During the pilot test, a strong relationship between color and oxidant demand was observed. A plot of PAA demand data for doses less than 13 mg/L that provided measurable residuals is shown in **Figure 3-2**. Using apparent color as an indicator, the chemical demand may be estimated and added to the target residual to support process control for the chemical feed systems. Additional online monitoring for PAA residual would be required to provide that the minimum target residual would be consistently achieved.

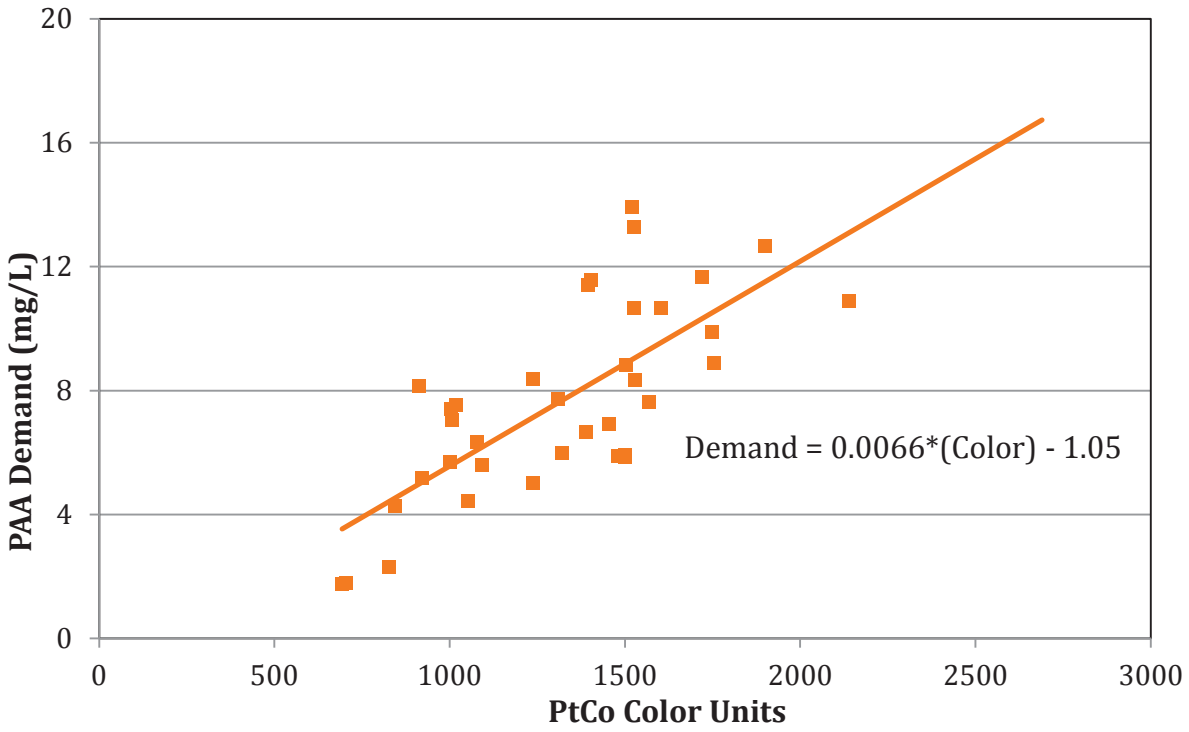


Figure 3-2 PAA Demand as a Function of Color

Because there is high variability in effluent color, four ranges were identified for establishing chemical dose rates (**Table 3-3**). Using historical data, average color in the effluent is approximately 749 PtCo color units which will be used to establish the average dosing requirements. In order to establish the basis for design, it is necessary to determine the range of PAA doses that provide the required inactivation rates. Based upon the methodology and findings in the *NPDES Disinfection Study Project Stiles WWTP Pilot Testing Report* (CDM Smith, 2013), the PAA dosing requirements range from 4.3 to 19.2 mg/L depending upon color as shown in **Table 3-1**.

Table 3-1 Summary of Design Doses for PAA as a Function of Effluent Color

Color (PtCo Units)	< 750	750 - 1500	1500 - 2000	2000 – 2500	> 2500
Chemical Demand	3.9	8.9	12.2	15.5	18.8
Target TRC	0.4				
Required Dose	4.3	9.3	12.6	15.9	19.2
Mixing Factor			1.3		
Design Dose	5.6	12.1	16	21	25

3.2 Sizing and Selection of Process Equipment

The PAA chemical provider will lease process equipment to the City of Memphis as part of the PAA chemical purchase agreement. Equipment cut sheets and correspondence regarding the proposed equipment are provided in **Appendix B**. **Table 3-3** summarizes the basis of design for the various components used in the PAA chemical delivery, storage and feed equipment. A summary of the process equipment and preliminary sizing is provided in **Table 3-4**.

Table 3-3 Basis of Design

Design Plant Flows		
Maximum Daily Flow (MaxDF)	250	MGD
Future Peak Hourly Flow	--	MGD
Design Average Daily Flow (Current Observed ADF)	94	MGD
Minimum Daily Flow (MinDF)	58	MGD
PAA Contact Channel Design Criteria		
Number of Trains	2	#s
Number of Passes per Train	8	#s
Design Flow per Contact Train	125	MGD
Design Contact Time	15.00	Min
Existing Channel Length per Train	568	ft
Existing Channel Length per Pass	71	ft
Existing Channel Width per Train	20	ft
Existing Channel Side Water Depth (SWD) per Train @PHF	12	ft
Existing Channel Length : Width Ratio per Train	56.8:1	40:1 required
Existing Channel Depth : Width Ratio	0.6:1	
PAA Mixing Design Criteria		
Number of Mixers / Mixing Chambers	1 mixer in each chamber / 2 mixing chambers	#s
Chamber Dimensions	17’ (L) x 9' (W) x 12' (D)	
Chamber Volume	1836	cft
Minimum Required Velocity Gradient	TBD	Sec^{-1}
PAA Feed & Pumps Design Criteria		
PAA Chemical Strength [1)]	12 to 15%	
PAA Specific Gravity	1.16	
Design Flows for Feed Rate Calcs (per train)		
Max DF max.	125	MGD
ADF avg.	47	MGD
Min DF min.	29	MGD
PAA Doses of Active Ingredient for Feed Rate Calcs [2)]		
Max.	16	mg/l
Avg.	12.1	mg/l
Min.	5.6	mg/l
Feed Rates per Pump dedicated to Train (for 15% solution) [3)]		
Max. flow and max. dose	478.9	gph
Avg. flow and avg. dose	136.2	gph
Min. flow and min. dose	38.9	gph
Pump Turn Down	12:1	
Minimum # of Metering Pumps per Train	2 (1 duty and 1 standby)	
Bulk Storage and Tanks Design Criteria		
Transfer Pumps	2	#s
Fill Station/ Piping/ Valves	Per Manufacturer	
Design Flow for Bulk Storage Calculations Plant Design ADF	135	MGD
PAA Volume per Truck Load	4,000	gal
14 day storage volume at ADF x Max Dose	173,793	gal
14 day storage volume at ADF x Avg Dose	131,431	gal
Total Storage Volume Selected	150,000	gal

Design Plant Flows		
Proposed Storage Volume per Tank	12,500	gal
Number of Bulk Tanks	12	#s
Proposed Storage Duration available at ADF x Avg Dose	16	days
Proposed Storage Duration available at ADF x Max Dose	12	days

Notes:
1) As active ingredient
2) Dose from *NPDES Disinfection Study Project Stiles WWTP Pilot Testing Report* (CDM Smith, 2013)
3) Pump sizing shall include 20% extra capacity if turn down can be achieved

Table 3-4 Summary of New Process Equipment

Equipment	Quantity	Size	Supplied By	Notes
Slide Gate in Contact Basin	4	60" x 60"	CDM Smith	Manually operated
Scum Trough	2	12" dia, 20' long	CDM Smith	Manually operated
PAA Bulk Storage Tanks	12	12,500 gal	PAA Supplier	Double Wall Captor HDPE, 150,000 gal total
PAA Day Transfer Tank	2	2,500 gal	PAA Supplier	Double Wall HDPE
PAA Transfer Pump	4	50 - 100 gpm	PAA Supplier	Air Operated Diaphragm Pump
PAA Feed Pump	4	22 gpm	PAA Supplier	Gear type pump
Air Compressor	2	75 hp	CDM Smith	300 acfm at 80-100 psi
Mud Valves	2	18"	CDM Smith	Manually operated, non-rising stem

Based on these equipment selections, **Appendix C, Drawings G-01, C-01, M-01, and M-02** illustrate the proposed chemical delivery, storage and feed system.

3.2.1 Chemical Off-Loading and Storage

PAA will be delivered on site by a WB-67 (18 wheeler) truck with a 53 foot trailer. The truck will deliver 4,000 gallons per delivery. The average daily chemical use is anticipated to be either 6,600 or 8,200 gallons, depending on the chemical concentration, which will require approximately two chemical deliveries per day. Due to the frequency of deliveries, a dedicated area for chemical off-loading is provided for spill containment. A description of road improvements to allow large trucks to access the PAA storage area is provided in Section 4.

A chemical delivery station (**Drawing M-01, Appendix C**) will be provided to facilitate off-loading of PAA from the delivery truck to bulk storage tanks. Chemical transfer will be accomplished using air operated diaphragm pumps (unloading pumps) provided by the PAA supplier. Displaced air from the bulk storage tanks will be captured and returned to the PAA delivery truck, through a closed loop system which reduces release of PAA vapor to the atmosphere. An interface control system will be incorporated to unload chemical to operator selected bulk storage tanks. The off-loading system will provide ability to fill multiple tanks simultaneously. A pre-engineered metal canopy will be provided above the pumps and control panels to protect the equipment from the weather.

Twelve 12,500-gallon, double-walled, high density polyethylene (HDPE) bulk storage tanks and two 2,500-gallon, double-walled HDPE day tanks are proposed as part of the chemical storage and delivery system. The total bulk storage is approximately 150,000 gallons, equivalent to 16 days of PAA disinfection operation at 135 mgd (average flow) at an average dose of 12.1 mg/L of PAA, as active ingredient.

The tanks will be provided with the following minimum features:

- Leak detection sensors that alert plant operators of leaks via a cellular auto-dialer
- Double-walled containment
- Radar level transmitter and a high-high conductivity level switch
- Combination pressure and vacuum relief vents
- Sight gauges
- Manway hatches
- Fiberglass reinforced polymer (FRP) ladders with safety cages
- Isolation valves
- Vent return lines

Two air diaphragm chemical transfer pumps will be used to transfer PAA from the bulk storage tanks to the two day tanks located adjacent to the PAA building. The transfer pumps and control panels will be protected from the weather by a pre-engineered metal canopy. The day tanks will be provided with a vent line that returns displaced air to the bulk tanks for storage and collection by the PAA delivery trucks. The day tanks will also be double-walled with similar features as the larger bulk tanks.

Because there is no air supply currently available at the PAA feed site, an air compressor will be provided for the transfer and unloading pumps. Approximately 300 cubic feet of air per minute (cfm) is required for pump operation during peak demand. The air compressors will be skid-mounted and placed in the renovated chlorine building. The vapor and tank fill lines will be mounted approximately three to four feet off the bottom slab using a pipe rack as shown in **Drawing M-01** provided in **Appendix C**. Buried suction lines will be used to transfer PAA from the day-tank to the chemical feed building. Above grade air lines would be of stainless steel or galvanized steel to prevent weathering.

3.2.2 Chemical Feed and Mixing System

Skid-mounted, self-priming gear pumps are proposed for dosing PAA. One pump will be used during average flows and average demands. A second pump will be utilized during peak flows and chemical demands. Two installed spares will be provided for a total of four installed metering pumps. The controls for the PAA feed pumps are discussed in **Section 5.6**. The pumps will be located on the upper floor of the renovated chlorine building as shown in **Drawing M-02** provided in **Appendix C**. Features of the chemical feed pump skids will include:

- Containment pad
- Leak-detection on the skids to detect PAA leaks in the building
- Local control panel for operator interface
- Pump failure alarms
- PAA flow measurement devices for tracking chemical feed rates
- Microprocessor based motor speed control unit to modulate chemical feed rate and control the pumps
- Calibration column

The gear pumps will pump PAA from the day tanks to the Contact Basin. There, chemical mixing will be performed in newly constructed mixing chambers in the existing contact basin (**Drawing M-03, Appendix C**).

At the time of this PER, a mixer selection has not been made for installation in the contact basin; this equipment selection will be made during detailed design. As a conservative estimate to support electrical demand requirements, CDM Smith selected two extended shaft mechanical mixers for installation in the junction box, similar to the existing equipment. These mixers were sized to provide a minimum G-value of 800 sec^{-1}. The 150 hp mixers will provide adequate mixing for the PAA disinfectant chemical.

Section 4

Existing Chlorine Contact Tank

The Stiles WWTP, constructed in the early 1970's, was originally designed to use chlorine disinfection in a contact basin that provides a 15 minute contact time at peak flow. The existing contact basin will be improved for use with peracetic acid as a disinfectant. A structural inspection was performed of the tank in November 2013 to determine if repairs were necessary to use this structure for PAA disinfection. This section summarizes the existing structural condition of the basin and outlines proposed improvements needed to utilize the basin for PAA and extend the useful life of the basin.

4.1 Condition of Existing Contact Basin

A visual structural inspection of the existing chlorine contact tank at the Stiles WWTP was performed on November 5, 2013 for the north half of the structure and on November 19, 2013 for the south half of the structure. The purpose of the visual inspection was to assess the overall condition of the structure and provide recommendations for repairs required to extend the useful life of the structure. The condition of the tank is summarized below:

- The condition of the concrete on the exterior above grade portions of the walls was found to be in good to fair condition. There were several structural cracks, numerous hairline cracks on the walls and walkway slabs. The exposed surface of the concrete was worn with exposed aggregate in many areas.
- The expansion joints in each direction were in poor condition and the concrete in the area of the expansion joint was spalled. The waterstop in the center divider wall expansion joint has failed. Water flows freely through the joint.
- The condition of the concrete walls and base slab below the normal liquid level was generally found to be good. An area of spalled concrete was observed near the beam near the northwest corner of the structure. Numerous areas with "pop outs" were observed on the base slab.
- Several areas had exposed reinforcing bars.
- Vertical cracks were observed in the center divider wall. Some of these cracks extended through the width of the wall.
- Guardrail was damaged in places and was missing on part of the effluent outfall box and mixing chamber.

Figure 4-1 Deteriorated Expansion Joint and spalled Concrete on Northwest Corner

Figure 4-2 Leaking Expansion Joint In Center Divider Wall

- Approximately 13 of the pressure relief (flap) valves had missing caps.

Overall, the chlorine contact chamber is in good condition considering its age. The structure needs certain repairs and rehabilitation to protect and extend its useful life. Protecting the reinforcing steel by repairing the areas with exposed rebar is critical to maintaining the strength of the structure. Additionally, adding a coating to the chlorine contact basin to protect the concrete from further attack is highly recommended. Repairing damaged guardrail connections and providing missing guardrail are also necessary to provide a safe working environment.

Figure 4-3 Missing Guardrail on Mixing Chamber

Figure 4-4 Typical guardrail Post with Broken Welded Connection

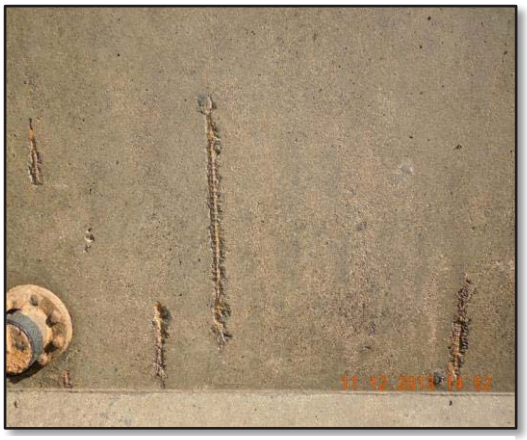


Figure 4-5 Exposed Vertical Reinforcing

4.2 Mechanical Improvements

The 40 year old valves and gates located in the tank structure were determined to be in generally good condition. While the basin is out of service for repairs, the influent slide gates and mud valves will also be replaced to extend their useful life. With the change to PAA, passivated stainless steel is recommended for new mechanical fittings, as well as neoprene, polyethylene, Teflon, or other approved materials for seals for chemical resistance.

4.2.1 Influent Slide Gates and Mud Valves

There are four 60-inch square slide gates leading from the mixing area into the PAA contact tank. The existing slide gates are recommended to be replaced with new stainless steel gates of the same size and configuration. These gates are in the mixing zone of the tank and will be in contact with the highest concentrations of PAA therefore replacement of the gates with compatible materials is recommended while the contact basin rehabilitation is being undertaken. The gates will be provided with neoprene bottom seals, self-adjusting

Figure 4-6 Influent Slide Gate seen from Contact Basin

UHMWPE side and top seals, and neoprene side and top compression cords.

The existing mud valves will also be replaced with 18-inch fabricated 316 stainless steel non-rising stem mud valves including EPDM seats to provide PAA chemical resistance. The valves will include a 2" operating nut.

4.2.2 Flow Measurement

Effluent flow is not currently measured at the contact basin. Effluent leaves the contact basin over a final weir before flowing through the outfall to the Mississippi River. Measuring effluent flow is recommended for the purposes of providing a primary signal for process control, as well as for billing purposes for treatment that is based on a dollar per million gallons treated, and not by dollar per pound of chemical used. Due to the configuration of the weirs, it is not recommended to utilize the weirs for flow measurement due to concerns regarding measurement accuracy.

Figure 4-7 Influent Slide Gate Operators

It is proposed to use full profile insertion mag- meters inserted into each of the two 96-inch influent pipes entering the contact basin junction box on each train. These meters will be located inside a manhole placed on top of the pipes for easy access as shown on **Figure C-01 in Appendix C**. Accuracy of these meters is typically within 1-percent for flows with velocities from 0.3 to 1 foot per second and 0.5-percent for flows with velocities greater than 1 foot per second. The minimum flow velocity through the pipe exceeds 0.3 feet per second.

An ultrasonic meter will also be installed over each of the effluent weirs as a secondary method of flow measurement. The insertion flow meters will provide a more accurate flow measurement and will be used to calibrate the ultrasonic flow meters over the weirs in the field. In the event of a failure of one of the primary insertion meters, the secondary ultrasonic level transmitter will be able to provide adequate flow measurement for billing purposes.

4.3 Sludge Removal

The contact basins were drained in order to perform the structural inspection in November. After draining, settled sludge in the bottom of the tank amounted to no more than 2-inches. Discussion with plant operations staff on November 6, 2013 yielded that prior to this inspection the basin had been drained and cleaned two years prior to the November inspection. Due to the small amount of solids deposition in the tank, no additional sludge removal is recommended. Instead, it is recommended that the plant add cleaning the basin a minimum of twice annually to the maintenance program since accumulated solids may increase the PAA demand in the tanks.

Section 5

Support Disciplines

5.1 Geotechnical Analysis

5.1.1 Field Exploration

Three borings, see **Drawing C-01, Appendix C**, will be required to investigate the subsurface conditions for tanks and structures. These borings should be extended through the existing fill soils anticipated in the area, and be terminated at a minimum depth of 30 feet, or at least 10 feet into native soil, whichever is deeper. Sampling should be continuous to the bottom of the fill materials and then two samples should be obtained for every five (5) feet of drilling to boring termination. Split spoon sampling should be conducted in soils cohesion-less and low-cohesion soils in general accordance with ASTM D1586. Cohesive soils should be sampled using Shelby tube samplers in general accordance with ASTM D1587. Continuous core sampling may also be performed in the upper zone of the samples.

Three shallow paving cores are recommended to confirm the condition of the existing pavement. These cores are discussed in Section 5.2.

One of the test boring excavations should be converted into a temporary piezometer to monitor groundwater levels for several weeks after drilling is completed. Groundwater levels can impact compaction and dewatering requirements during construction.

All borings should be pressure grouted upon completion or when the piezometer is removed (it is recommended that water levels in the temporary piezometer be read twice a week and the piezometer removed 3 to 4 weeks after it is installed).

Field exploration will be coordinated with work related to the ongoing Stiles Outfall project.

5.1.2 Geotechnical Laboratory Testing

Geotechnical laboratory tests should be performed on select samples obtained from the test borings. The purpose of these tests, which should be performed in accordance with applicable ASTM standards, is to evaluate:

- Index properties including but not limited to moisture content grain size and Atterberg limits performed in accordance with applicable ASTM standards;
- Strength properties including but not limited to unconfined compression and triaxial compression tests to evaluate the drained and undrained shear strength of the cohesive soils.

5.1.3 Geotechnical Design Recommendations

The results of field and laboratory data should be analyzed to provide the following geotechnical recommendations:

- Foundation type and soil design parameters for allowable bearing pressure, sliding or lateral resistance on the base of the foundation, an estimate of total and differential settlement, and

any pertinent soil behavior (i.e. expansive soils) known to occur in the region, to be accounted for in design of the proposed basin and containment area structures.

- Lateral loads for backfill placed behind below grade walls, including drained and undrained loading conditions and the effects of surcharge loads on the ground surface adjacent to the walls.
- Descriptions of acceptable fill materials for use as general fill, select fill, structural fill and soil requirements for materials to be used as backfill behind below-grade walls, including methods for placement and compaction of these fill materials.
- Preparation of subgrades to receive slabs and paving, including removal of undesirable materials (i.e. existing fills), compaction requirements and expected subgrade support. The presence of existing fills, their partial or total removal and the impact on long term settlement should specifically be addressed at each new structure location and, below any proposed paving.
- Seismic site classification for foundation and structure design based on Building Code
- A discussion of construction considerations for the geotechnical recommendations provided, including excavation sloping and shoring, dewatering and buoyancy of the completed structures.
- Pavement design recommendations for proposed pavement repairs outlined in Section 5.2

5.2 Site Plan and Civil Design Elements

The preliminary site plan is provided in **Figure C-01 and C-02 in Appendix C**. The site plan indicates key elements for the PAA system including chemical off-loading and storage, site piping, and roadway/access improvements. Each element is discussed in detail below.

5.2.1 Chemical Delivery and Site Access

Access to the Stiles WWTP is from North 2nd Street thence Stiles Drive to Street A thence Street D. Street D is the loop road that provides access to the chemical delivery site (**Drawing C-02, Appendix C**). The existing roads consist of compacted base topped with 3-inches of asphaltic concrete with curb and gutter.

Chemical delivery will be provided by bulk delivery using a WB-67 (18 wheeler) truck. The existing roadway layouts were reviewed to determine if there was adequate turning radius for the delivery vehicles entering each turn clockwise and counter clockwise. Preliminary evaluation indicates that most turns will require some improvements to adequately provide clearances for the truck turns. The main access from North 2nd Street was not included in the preliminary evaluation because the access already accommodates 18 wheeler vehicles and is therefore assumed as adequate for the chemical delivery trucks.

Figure 5-1 Typical Roadway Section with Curb and Gutter

5.2.1.1 Stiles Road to Street A and Street A Curves

As shown in **Drawing C-02**, **Appendix C,** the turn into and out of Street A is not adequate to accommodate the delivery vehicles. The turning radius should be widened as indicated to provide the minimum curve for keeping all wheels of the truck on pavement.

There is an approximate 90 degree turn along Street A toward the main plant. The delivery truck can likely navigate the turn with all wheels remaining on pavement by using the full width of the roadway. However, additional width at the turn will improve the navigation. This will require relocation of a light pole and approximately 780 square feet (sf) of additional pavement. The need for these improvements should be considered further during final design.

It is important to note that in all turns described above, it has been assumed the delivery vehicle can use the full width of the road regardless of lanes. This assumption is based upon the limited use of the roadways. If the truck is restricted to single lane use, additional width for all turns will be required.

5.2.1.2 Street A to Street D and Street D Curves

Street D is the loop road around the main plant. A curve analysis was conducted using a clockwise and counter clockwise driving pattern. In both scenarios, curves 1 and 2 do not appear to have adequate width to functionally accommodate the turning truck and have all wheels remain on pavement. Curve 1 should be widened slightly on the inside turn. Some additional pavement width along the stretch between curve 1 and 2 should be considered in the event of counter clockwise entrance. With full use of the driving lane for turning, the wheels will not remain fully on pavement coming out of the turn. Curve 2 should be widened on the inside and outside turns. Curve 3 is a new curve with a recommended radius of 154 feet to accommodate the turning truck. Curve 4 appears to be adequate for a counter clockwise entrance but provides only the minimum clearance for clockwise turning with a precise turn. Approximately 370 sf of additional pavement may be warranted for this turn.

5.2.2 Chemical Off-Loading and Containment

The chemical delivery area is located east of the converted chlorine contact basin in the southwest inside corner of Street D, adjacent to the chemical storage tanks. The delivery area provides parking parallel for the truck next to the chemical containment area for off-loading activities. Curbing and bollards will be provided to protect the containment area. A sump is recommended to capture any leakage in the unloading area. In the event of major leakage, the sump will provide containment in combination with the curbed unloading area. A walkway between the delivery area and the storage tanks will provide access for personnel and space for tank fill quick connects and controls. Pavement in the off-loading area will be concrete and will be treated with a special coating that will protect against PAA chemical spills.

A containment area with a curb will be provided around the bulk storage tanks. This curb will be approximately 18-inches high and will provide containment of rainwater equal to the 25 year, 24-hour storm for the area and one bulk tank spill. The containment curb and concrete around the storage tanks will be treated with the same coating as the concrete pavement in the off-loading area.

5.2.3 Yard Piping

Yard piping improvements will consist of new buried piping for disinfectant chemical transfer and feed, air supply, potable water, and relocation of existing plant utilities. (**Drawing C-01, Appendix C**).

Piping that will need to be relocated include a 24-inch effluent water line and a 5-inch spray water line. These are close to the footprint of the chemical storage area and are recommended to be relocated to avoid conflict with any foundations.

New buried piping will include potable water from existing plant supply for eye washes and spray hoses, air supply from the chemical building to the air operated diaphragm pumps, and chemical transfer lines from the day tank to the dosing pumps. Feed lines from the chemical metering pumps to the junction box of the PAA contact tank will be installed in either a casing pipe or trench with traffic-rated heavy duty grating.

5.3 Architecture

The existing chlorine building will be renovated to store the air compressors and PAA chemical feed pumps. This section provides a summary of the building code implications of the proposed renovations to the existing structure.

Codes referenced:

- 2012 International Building Code (IBC)
- 2012 International Existing Building Code (IEBC)
- 2013 International Fire Code (IFC)

A 15-percent PAA solution is classified in accordance with the International Fire Code as possessing the following Physical properties: (The maximum numbers are for a chemical in a closed-system)

▪ Combustible liquid	Class III-A	H-2 or H-3 occupancy if over 330 gallons
▪ Organic Peroxide	Class IV	
▪ Oxidizer Solid/Liquid	Class II	H-3 Occupancy if over 25 gallons

A 15-percent PAA solution is also classified in accordance with the International Fire Code as possessing the following Health properties (maximum numbers are for a chemical in a closed-system):

- Corrosive H-4 occupancy if chemical volume is over 500 gallons
- Toxic H-4 occupancy if chemical volume is over 50 gallons

Within a closed system, if the amount of PAA exceeds the amounts listed above, an H occupancy classification will be triggered. H Occupancy requirements include, among others, automatic fire sprinklers and detectors, fire rated walls and floors and exterior venting.

At this time, the anticipated amount of PAA within the area of work is less than 25 gallons, at any one time, contained entirely within a closed system.

Based on the anticipated amount of PAA it is anticipated that the building Group Occupancy will be classified as F-1 Factory Industrial, with no anticipated change in egress and no anticipated change in building area and building height required.

The anticipated classification of work as defined by the IEBC is alteration Level 2. Alteration level 2 involves the addition of equipment or reconfiguration or extension of a system.

In regards to the exterior storage, if the amount exceeds 100 gallons, storage containers must have a minimum 35-ft setback from buildings, lot lines, public right of ways and means of egress (Table 6304.2.1 and 6304.1.2 in the 2012 International Fire Code).

This preliminary building code review was conducted to review the existing building occupancy group and determine if it was impacted by the addition of PAA. A full building code review will be provided during final design.

5.4 Structural

Discussion of the renovations to the chlorine contact basins was included in Section 4. The required structural modifications to the existing facilities are provided in this section.

5.4.1 Chemical Building

A visual structural inspection of the existing chlorine building at the Stiles WWTP was performed on November 5, 2013. The purpose of the visual inspection was to assess the overall condition of the structure and provide recommendations for repairs required to extend the useful life of the structure. The inspection included visual observations, concrete sounding using a hammer, measurement using a tape measure to verify dimensions, as well as taking photographs.

The original design drawings indicate the structure was designed in 1972. The structure is 82'-0"" (North-South) by 24'-6" (East-West). The structure has two levels, the lower level foundation is constructed at elevation 225.50', the ground floor slab is at elevation 242.50', and the roof slab is at elevation 258.5'. The below grade walls are constructed of cast in place concrete and are indicated to be 1'-3" thick. The above grade walls are constructed of 10" cast in place concrete with a 4" brick veneer. The foundation is constructed of a 12" thick cast in place concrete mat foundation supported by 40 ton capacity piles located under the perimeter concrete walls. The ground floor slab is a 10" thick cast in place concrete slab with cast in place concrete beams. The roof slab is a 7" thick cast in place concrete slab with cast in place concrete roof beams. The lower level is connected to the lower level of the Sludge Pump building.

Figure 5-2 Interior of the Chemical Building to be retrofitted, currently used as storage

5.4.1.1 Building Visual Inspection

The reinforced concrete walls, slabs and brick veneer were found to be in very good condition at the time of the inspection. There were no signs of cracks or structural distress noted at the time of the inspection. The roof was not inspected however there were no visible signs of leakage into the building at the time of the inspection.

5.4.1.2 Repair and Rehabilitation Recommendations

The recommendations for modification of the structure are primarily aesthetic in nature.

- Repair wall air conditioning unit in the northeast corner of the structure and re-paint wall to protect from moisture damage.
- Monitor brick and repair any damage to the brick and/or mortar quickly to avoid costly repairs in the future.
- If roofing membrane is more than 20 years old, consider replacing the membrane to avoid water leaking onto new equipment.

Modifications to the structure (i.e. adding new doors, windows, louvers) or increasing the loads on the structure (i.e. more equipment and/or heavier equipment) will require a structural review and analysis. The addition of openings will require a new wind analysis to determine the wind classification of the modified structure (enclosed, partially enclosed, etc.). Wind loads will be calculated based on the modified structure and any modifications will be required to meet the current building code requirements. Additionally, if the stresses on any existing structural member are increased by more than 5%, a seismic analysis will need to be performed and strengthening of the affected members to meet the current seismic loading requirements will be required. These activities will be performed during final design.

The chlorine building is in very good condition. The repairs and preventative maintenance items listed are recommended to protect and extend its useful life.

5.4.1.3 Asbestos and Lead Based Paint

During final design, a lead-based paint and asbestos inspection is recommended for any portions of the chemical building that will be modified or altered during construction. It is recommended that the surveys consist of a thorough inspection for the presence of potential lead-based paint or asbestos, including category I and category II nonfriable asbestos, prior to the demolition or modification to the building. The areas identified as containing asbestos or lead-based paint will be delineated on the plans or in the specifications along with minimum management practices. This inspection will likely include sampling and analysis by an accredited laboratory to determine the presence of lead based paint or asbestos.

5.4.2 Chemical Storage Area

The large number of chemical storage tanks to be placed on site requires a chemical containment structure. The chemical storage area is shown in **Drawing M-01, Appendix C** and includes twelve bulk storage tanks and two day tanks. The chemical storage area will be constructed of a cast in place structure that features a containment wall around the perimeter. Each tank will be placed on a pedestal which will also be a cast in place structure. Foundation design for the storage area and the tank pedestals will be determined after geotechnical borings are performed, but the construction is assumed to be slab on grade. Boring locations are shown on **Drawing C-01, Appendix C.** Protective coatings will be applied to all concrete surfaces of the chemical storage area to protect the concrete from any chemical spills that may occur.

5.5 HVAC and Plumbing

5.5.1 Plumbing

5.5.1.1 System Description

The plumbing system improvements will consist of combination emergency shower/eyewash units, wash hose stations, and equipment drainage. Potable water will be provided by tying into the existing potable water system. Protected water for supplying non-potable connections will be provided by installing backflow preventers on the potable water system. PVC pipe and fittings will be used for water lines for corrosion resistance. Potable water lines above grade will be heat-traced and insulated to provide protection from freezing and UV exposure.

In areas with corrosive chemicals, combination emergency showers/eyewash units shall be provided for safety purposes in order to allow eyes or skin to be flush with water after accidental chemical exposures. These units shall be located to limit the maximum walking distance to 55’ between the

potential exposure hazard and the nearest unit. ANSI standard Z358.1 requires tepid potable water (60°F-100°F) be supplied to emergency showers and eyewashes. In order to provide tepid potable water for emergency eye showers/eyewash, an instantaneous water heating system will be included. This will involve a separate loop of tepid potable water routed to the eye washes and showers. A flow switch to activate a local alarm (horn and beacon light at the shower unit) and a remote alarm (to the SCADA) is typically provided for emergency showers and eyewashes. It is recommended that these alarms be provided at each unit.

5.5.1.2 PAA Room

An emergency shower/eyewash unit shall be provided inside the PAA room near the PAA feed pump skid. This unit will be supplied with potable water from the existing water system. Any above ground outdoor water lines where are added to supply this unit will be heat traced and insulated for freeze protection.

The PAA room has existing floor drains. These floor drains will be reused for any new drainage flows.

5.5.1.3 Chemical Storage Area

Emergency showers/eyewash units shall be provided inside chemical storage area and at the truck unloading area. The safety units in this area will be located throughout the containment area and will be space in accordance with the limits stated above.

Wash hose stations will be provided in and around the chemical storage area. The hose bibs shall be spaced so that the entire containment area can washed down with no more than a 50' hose length. Because wash hose stations are a potential source of backflow and contamination of the potable water source, backflow preventers shall be provided at each hose bib. Backflow preventers will not be located inside the containment area. A caution sign will be posted at each hose bib warning personnel that the water is not safe to drink. All above ground outdoor water lines shall be heat traced and insulated for freeze protection.

5.5.2 HVAC

5.5.2.1 Design Criteria

The HVAC systems will be designed using the following criteria:

Table 5-1 HVAC Design Criteria – Outdoor Conditions

Parameter	Design Criteria
Winter Temperature	ASHRAE 99.6% Dry Bulb: 18.7°F
Summer Temperature	ASHRAE 0.4% Dry Bulb/Mean Wet Bulb: 96.7°F/77.2°F
Latitude/Longitude	35.06 N/89.99 W
Elevation	331 ft.

Note:
Based on 2013 ASHRAE (American Society of Heating, Refrigeration and Air-Conditioning Engineers, Inc.) Fundamentals, Climatic Design Information for Memphis International Airport.

Table 5-2 HVAC Design Criteria – Indoor Conditions

Area	Summer		Winter		Notes
	Temp (°F)	Outside Air	Temp (°F)	Outside Air	
PAA Room	Max 10°F above ambient	N/A	55 ± 2	N/A	1
Electrical Room	85 ± 2	N/A	55 ± 2	N/A	2

Notes:
1. The space will be ventilated in the summer and heated in the winter. No continuous ventilation will be provided.
2. The space will be air-conditioned year-round as needed and heated in the winter. No ventilation air will be provided.

5.5.2.2 PAA Room

The PAA room will be ventilated to maintain indoor conditions at a maximum of 10°F above ambient in summer. The ventilation system will consist of a wall louver with a motorized damper and an exhaust fan. Cooler outside air will be brought into the space through the intake louver. Warm air near the roof will be removed from the space with an exhaust fan. The fan and louver will be sized to remove heat gains from process equipment and from the building envelope. The ventilation system will be thermostatically controlled to operate only when the room temperature is high.

The PAA room will be heated to maintain a minimum of 55°F in winter. The heating system shall consist of a wall-mounted electric unit heater. The unit heater will be provided with an integral thermostat with adjustable set point.

The intake for air compressors located in the PAA room will be piped to draw air from outdoors instead of from inside the room. This will eliminate the need for an extra louver or ventilation opening which is always open to outdoors and reduce the required heating during colder weather. The vent on the PAA feed system calibration columns will also be piped to outdoors in order to vent any corrosive fumes to atmosphere and not into the room.

5.5.2.3 Electrical Room

The electrical room will be heated and conditioned to maintain an indoor temperature range of 55°F to 85°F. The HVAC system will consist of direct expansion (DX) air conditioning (a/c system with integral heating. The a/c unit will be provided with a low ambient cooling option, to allow the cooling mode to operate during cold ambient conditions. The heating source (heat pump, electric, gas) will be evaluated during detailed design. A second a/c unit may be provided for cooling system redundancy. As an alternative, a temperature sensor or high temperature switch may be installed inside the electrical room instead to alarm of "HIGH TEMPERATURE" conditions due to cooling system failure that could result in electrical equipment shutdown or failure. Corrosion resistance coatings for the unit housing and the a/c coils will be evaluated during detailed design.

The a/c unit shall be controlled by an adjustable thermostat located in the electrical room. If the supply airflow of the a/c unit equals 2000 cfm or more duct smoke detectors shall be provided in the supply and return ducts of the unit. If smoke is detected, the sensor will cause the supply unit to shut down and will send an alarm to SCADA as well as local audible and visual alarm.

Ductwork will be fabricated from aluminum sheet metal. Ductwork will be provided with external insulation when running outdoors or through unconditioned spaces. No ductwork shall be routed above electrical equipment. The condensate drain from the a/c unit will be piped either outside or to a nearby floor drain. No condensate drains shall be routed through the electrical room.

Electronic equipment can be very sensitive to corrosion from harsh environments like wastewater treatment plants. Positive pressurization units are commonly used in spaces with sensitive electronics such as electrical room and control room in order reduce the corrosion to that equipment. A positive pressurization unit typically functions by scrubbing the indoor air to chemical media to strip out the corrosive contaminants and also by supplying treated outside air in order to reduce the leakage of untreated outside air and its contaminants into the space. The need for a positive pressurization unit will be evaluated during detailed design.

5.6 Instrumentation and Controls

Instrumentation and controls are critical to the operation of the packaged PAA system and careful coordination for interfacing the new PAA system with the existing and proposed plant SCADA systems.

The PAA system will be designed to dose PAA into the plant flow stream for disinfection. The major system components will be the PAA bulk storage area, the day tank storage area, and the PAA feed system. The system will be controlled by a PLC which will allow for all components to be automatically controlled and will provide the ability to alert the operator to process problems. An operator interface will provide the operator with a computer where the process can be monitored and controlled. The interface can also call the operator to notify them of alarms if they are not near the computer.

5.6.1 Bulk Tank Storage Area

The bulk tank storage area will contain 12 tanks for storage of PAA. Tanks will be located in a containment area that can be drained through a sump to collect and fluid that is collected within the containment area. The sump will be drained by gravity to a nearby drain line. If the source of the liquid is spilled PAA, a chemically compatible collection container can be used with a portable sump pump and the liquid can be pumped to the container and collected for disposal. If a wash-down of the area is required for spill mitigation and clean-up, the sump can be used for collecting the wash water and it can then be either pumped using a portable pump into a collection container or flow by gravity into the near-by drain line.

'The level in each 12,500 gallon bulk storage tank is continuously monitored by an ultrasonic level transmitter that is mounted in a flange in the top of the tank. A magnetic float type visual level gauge is also to be provided at each tank to allow for easy level monitoring by operators who are near the tanks. The level from the radar level transmitter is displayed locally at the tank, remotely at the operator interface, and at the tank fill station. High and low alarm setpoints are adjustable at the operator interface. Each tank is double walled to prevent leaks and the space between the walls is monitored for leaking. If fluid is detected between the walls, an alarm will notify the operator of the situation so that proper action can be determined and taken.

Each tank is equipped with a common fill line that allows PAA to be transferred from a 4,000 gallon truck to the tank using an air diaphragm pump. The delivery personnel will select the tank to be filled, which will open a solenoid valve on that tank. Once a tank has been selected, one of two redundant transfer pumps will be started manually and run until the desired level is reached. The pump will then be stopped, another tank selected, and the pump restarted until all tanks have been filled. If a tank is overfilled, a high level alarm will be reached and a horn and light will indicate a high level condition. At a high level setpoint the fill solenoid will be closed to prevent overfilling of the tank and the transfer pump will be stopped. In the event of a solenoid valve failure, spills will be prevented by adding a pressure-reducing valve and pressure switch to the fill line that will open and discharge PAA into a

tank rather than bursting the fill lines. This PRV and pressure switch will be monitored by the PAA control system isolation valves will be provided on either side of a solenoid valve for maintenance.

There are two options for filling the tanks. The first is to make the filling process entirely operator (manual) controlled. The operator would have a panel that would show all tank levels and would have a switch to open and close each tank fill solenoid and a switch to start each pump. The operator would monitor the levels and start and stop the pumps manually. A second option would be to have the operator select which tank they want to fill and have the PLC open the correct valves, start the pump, run it until a setpoint is reached, and stop the pump. This allows less operator involvement during the filling sequence. The tanks each have a volume of 12,500 gallons and the delivery trucks are anticipated to have a volume of 4,000 gallons which may result in multiple trucks filling each tank or a single truck having to "top off" multiple tanks.

The tanks are also connected by a common vent line; during filling, the gasses that are displaced are collected back in the truck to allow for the vapors to be collected and disposed. Each tank is equipped with an air vacuum release valve that will allow air to enter the tanks as PAA is pumped out and will prevent over pressurization of the tanks during filling. Safety showers will be located throughout the area as required by code and the showers will be monitored by the control system to notify the operator when a station has been activated.

5.6.2 Day Tank Storage Area

The day tank storage area will contain two smaller tanks that will hold PAA to be fed to the system. Like the storage area, the day tank area will be located within a containment area with a sump system that will drain it by gravity. Tank level monitoring and alarming will also be similar. Transfer of PAA from the storage area to the day tank area will be handled by two air diaphragm pumps. This transfer can either be performed manually by an operator, or can be designed to be automatic with a low level triggering a transfer and a high level ending it. Solenoids located at the inlet of each tank will allow the tanks to be filled independently.

The vent lines from the day tanks will be plumbed back to the bulk storage tanks to allow for vapors to be contained and collected to be carried away by the delivery truck. Safety showers will be located throughout the area as required by code and the showers will be monitored by the control system to notify the operator when a station has been activated.

5.6.3 PAA Feed System

Flow through the contact basin will be measured using the sum of two inline magnetic flow meters (otherwise known as insertion meters) installed on the 96-inch influent pipes to the chlorine contact tank as the primary flow measurement device for the system. As a secondary system, two ultrasonic flow meters will measure water level over the effluent weirs to calculate the effluent flow rate. The ultrasonic flow meters will need to be calibrated in the field by using the measurements from the insertion meters. After they are calibrated, they ultrasonic flow meters will act as a backup flow measurement device so that the failure of a single flow meter doesn't prevent the system from functioning. The operator will select which flow measurement device is to be used for dosing using a switch on the operator interface. High and low flow alarms can be configured as relevant for the process to aid the operator in identifying a problem.

Dosing will be conducted using four variable speed gear pumps. The pumps will be sized so that one or two are required to provide the required range of PAA flows with the other two acting as online

spares. The pumps will dose PAA proportionally based on the plant flow reading measured with a secondary loop acting to further adjust the dosing based on the residual PAA measurement in the contact basins to maintain a residual PAA of 0.4 mg/L. The pumps will operate in a lead/lag configuration with the other two pumps in standby. A failure of any pump will call one of the standby pumps into service and will notify the operator. Lead pump operation will alternate to exercise all four feed pumps.

At the feed point, mixers will distribute the PAA being added to the process flow to help optimize the disinfection process. The mixers will be monitored by the control system in order to notify the operator of a failure. The mixers are intended to operate at all times under normal operation. The type of mixer and sizing will be determined during detailed design. The option of a secondary dosing point will be evaluated in final design.

The PAA residual will be measured at two points in each flow path to allow monitoring of the efficacy of the system. The operator will select which analyzer shall be used in the control loop. This will allow for the controlling analyzer to be changing during servicing or calibration of the analyzers. All analyzers will be configured with high and low alarms to notify the operator of a process issue. These alarms will be equipped with a disable feature to eliminate nuisance alarms during periods when the analyzer is being maintained or is not functioning properly.

5.6.4 Sampling

With respect to effluent sampling, the permit states,

> *If chlorination is used for disinfection, final effluent BOD5 samples can be collected before disinfection to avoid having to dechlorinate and seed the samples. If a non-chlorination-based oxidation process is used for effluent disinfection, the permittee shall use BOD5 testing procedures approved by the division for its treated effluent analyses.*

Thus, for the purposes of this PER, it has been assumed that a similar approach could be applied to a PAA system to allow the City to avoid having to quench and seed samples, which would follow an identical process to chlorine based sampling. An autosampler will need to be installed ahead of the PAA feed point to collect the composite samples for permit monitoring. In addition, online PAA analyzers will be installed at the tank effluent to monitor PAA residual for controls.

5.7 Electrical

5.7.1 Codes, Standards, and References

The Stiles WWTP electrical work will comply with all federal, state and local laws or ordinances, as well as all applicable codes, standards, regulations and / or regulatory agency requirements including the partial listing below:

ANSI	American National Standards Institute
IEEE	Institute of Electrical and Electronic Engineers
IES	Illuminating Engineering Society Lighting Handbook
IPCEA	Insulated Power Cable Engineers Association
NESC	National Electrical Safety Code
NEC	National Electrical Code (NFPA 70)

NFPA	Life Safety Code (NFPA 101)
NFPA	Standard for Fire Protection in Wastewater Treatment and Collection Facilities (NFPA 820)
NEMA	National Electrical Manufacturers Association
NETA	International Electrical Testing Association
OSHA	Occupational Safety and Health Administration
FM	Factory Mutual
UL	Underwriters Laboratories

5.7.2 Distribution Design Criteria

The electrical distribution design criteria for the PAA system should include considerations for reliability, maintainability, and safety. To provide for a reliable distribution, the system should be designed with two independent sources of power and protection from common mode failures. This approach is in compliance with the Tennessee Department of Environment & Conservation's (TDEC) *Design Criteria for Sewage Works*.

The TDEC's Design Criteria addresses the power distribution "Within the Works," which is the wastewater treatment plant power distribution. The TDEC's Design Criteria states:

> *Service to Motor Control Centers - The internal power distribution system shall be designed such that no single fault or loss of a power source will result in disruption (i. e. , extended, not momentary) of electric service to more than one motor control center associated with the Reliability Class I, II, or III vital components requiring backup power.*
>
> *Division of Loads at Motor Control Centers - Vital components of the same type and serving the same function shall be divided as equally as possible between at least two motor control centers. Nonvital components shall be divided in a similar manner, where practicable.*

The TDEC's Design Criteria states:

> *Provisions for Equipment Testing - Provisions shall be included in the design of equipment requiring periodic testing, to enable the tests to be accomplished while maintaining electric power to all vital components. This requires being able to conduct tests, such as actuating and resetting automatic transfer switches, and starting and loading emergency generating equipment.*
>
> *Maintainability- The electric distribution system and equipment shall be designed to permit inspection and maintenance of individual items without causing a controlled diversion or causing violation of the effluent limitations.*

Providing an electrical distribution system that is easily maintained requires that a portion of the distribution be taken out of service for routine maintenance (e.g., cable testing, bus testing, circuit breaker inspection/testing), while a portion of the system remains operational. The considerations for safety are directly related to maintainability. If plant maintenance personnel can maintain the equipment and provide preventative maintenance, the possibility of failures, temporary connections, and equipment damage will be reduced.

The most practical distribution system for the PAA system is a dual-ended secondary selective design. This type of design provides a high level of reliability at a nominal cost. The distribution is divided into two parallel systems that have interconnecting tie breakers. In the normal mode of operation, each system or main feeder provides power for roughly one-half of all the plant electrical loads; however, all plant loads required for operation could be carried by a single feeder if required to do so. This arrangement allows for system maintenance with minimal or small interruption of plant operations or process. The secondary selective distribution system provides high reliability, flexibility, and maintainability, while minimizing system downtime.

The selection of the distribution voltage based on the equipment loads represented in the preliminary design phase will require dual 480 volt, 3-phase, 3-wire, 60 Hz, grounded wye distribution systems. The disinfection system will be a packaged (i.e. skid mounted type) systems, therefore the PAA specifications will be written such that the PAA system supplier will provide dual motor control centers (MCC) or panel boards with an interconnecting tie breaker to obtain the necessary reliability.

Based on the preliminary loading required for the PAA system equipment and a survey of the 1972 plant upgrade as-built drawings, the existing substations U-1, U-2 & U-3 are at capacity from a connected load standpoint. It is not recommended to add the critical PAA system loads to any of these existing substations. To accommodate the new PAA system loads, two new pad mounted transformers will be provided near the PAA system. The new transformers will be powered from existing 5 kV switchgear 'S-1' located in the existing blower building. New 5 kV breakers are proposed at existing switchgear 'S-1' to power the transformers. This will be coordinated further during detailed design with plant staff. Refer to single line in **Drawing E-2, Appendix C**. As-built drawings indicate space is available for new breakers in switchgear 'S-1'.

The proposed transformers are to be located as indicated on electrical site plan **Drawing E-1, Appendix C**. This area is preliminary and will be adjusted during final design to provide the most efficient location for operations and maintenance.

The new distribution transformers for the disinfection system equipment will be sized and rated to power each main breaker provided by the PAA system supplier. The PAA system supplier will include a dual-ended secondary selective type design (main-tie-main circuit breakers) within their system control panels and/or MCC's. During final design, the load of the PAA system will be reevaluated based on the most current loading requirements and the transformer or loading of the existing substations evaluated to provide the best and most cost effective design.

5.7.3 NFPA Design Criteria

NFPA *Standard for Fire Protection in Wastewater Treatment and Collection Facilities*, NFPA 820, is a nationally recognized standard for design of wastewater treatment plants. Many municipalities and authorities in Tennessee enforce the requirements of this document, which impacts the design of electrical equipment throughout the plant.

Although it is not clear how this document will be enforced by City of Memphis, we recommend that this criterion be used on all new construction. Work done for existing equipment and existing areas will be determined on a case-by-case basis using a risk assessment procedure.

5.7.4 Lighting System

Where required to meet codes, process area lighting for task and egress will be provided. Additional exterior building lighting and site lighting will be provided as required, unless otherwise specifically indicated and requested by the client.

Lighting fixtures mounted more than 15-feet high may use metal halide type lamps (with quartz lamp backups and standby system when initially energized). Fixtures in small areas or mounted 15-feet or less will be fluorescent type lamps either surface or pendant mounted. Fixtures will be rated at 120 volts. Illumination levels will be approximately 50 foot-candles in office areas, 50 foot-candles in process areas, 50 foot-candles in electrical rooms, 1 to 10 foot-candles for exterior areas or as required. Other areas will be reviewed during detailed design.

Where required, a 480-120/208 volt wye dry type transformer and panelboards will be used to operate the 120/208 volt loads such as lighting and receptacles, unless other voltages are required.

5.7.5 Grounding System

Grounding systems will be designed for all new building and structures in accordance with the NEC.

5.7.6 Surge Protection Devices

Surge protection devices will be provided for the electrical distribution system equipment to reduce the destructive effects of electrical transients and temporary excess voltage and/or current in the electrical circuits. The SPD devices will be incorporated to limit short duration events, typically lasting from a few thousandths of a second (milliseconds) to billionths of a second (nanoseconds).

The electrical system equipment will be protected by surge protection devices on the 480-volt line entering the switchgear, switchboards, motor control centers, and panelboards. The surge protection devices shall be listed in accordance with UL 1449 Third Edition and as defined by IEEE C62.41 and C62.45.

5.7.7 Motors

All motors will be of the premium efficiency, high power factor motors suitable for indoor or outdoor applications, as appropriate. Across-the-line starting will be utilized for all motors unless reduced voltage starters are required to meet restrictions by the power company.

Unless otherwise noted, all motors ½ horsepower through 100 horsepower shall be rated 230/460 volt, 3-phase, 60 Hertz A.C.; motors 125 horsepower and above shall be rated 460 volts, 3-phase, 60 Hertz A.C., and motors below ½ horsepower shall be rated 115/230 volt, 1-phase, 60 Hertz A.C. All motors used with variable frequency drives shall be rated for inverter duty and shall be in accordance with NEMA MG1, Section IV, Part 31. All motors operating with variable frequency drives shall be equipped with winding temperature detectors. Motors 50 horsepower and larger shall have a 120 volt space heater for moisture control.

5.7.8 Raceways

Raceway applications shall be as follows:

- Except where otherwise shown on the drawings, or specified, all wiring shall be in rigid aluminum conduit.

- Rigid aluminum conduit shall be used at all locations (underground and within structures) as raceways for shielded process instrumentation wiring, shielded control wiring, data highway wiring and I/O wiring.
- Schedule 80 PVC conduit shall be used where shown on the drawings and in chemical rooms, chemical storage areas or areas designated "CORROSIVE" on the drawings.
- Rigid aluminum conduit or Schedule 80 PVC conduit shall be used underground where concrete encasement is not called for or as noted above. Where Schedule 80 PVC is used, all elbows shall be rigid aluminum conduit.
- Schedule 40 PVC conduit shall be used for concrete-encased underground duct banks except as noted above.
- Electrical metallic tubing and fittings may be used only in NEMA 1 administration and office areas. Electrical metallic tubing and fittings shall not be embedded in concrete, installed outdoors, in process areas, shops, maintenance areas, electrical rooms, etc.

5.7.9 Wires and Cables

600 volt or less wires and cables shall be as follows:

- Wires and cables shall be annealed copper.
- Wire for lighting, receptacles, and other circuits not exceeding 150 volts to ground shall be NEC Type XHHW. Below grade and underground the wire shall be Type XHHW.
- Wire for circuits over 150 volts to ground shall be NEC Type XHHW for sizes 4/0 AWG and smaller, and shall be NEC Type RHW for sizes 250 kcmil and larger.
- Wire for control circuits shall be #14 AWG minimum NEC Type XHHW stranded.
- Equipment grounding conductors shall be NEC Type THW.
- Multi-conductor control cable shall be 600 volt, #14 AWG stranded, Type XLP insulated with PVC jacket.
- Multi-conductor power cable shall be stranded, 600 volt, Type XLP insulated with PVC jacket, Type “TC” (XLP) with ground.
- Process instrumentation wire shall be twisted pair, #14 AWG stranded, 600 volt, Type XLP insulated, aluminum tape shield, with PVC jacket.

5.7.10 Miscellaneous

NEMA enclosure, location and equipment classifications shall be as follows:

- Use NEMA 1 for dry, non-process indoor areas such as electrical rooms.
- Use NEMA 12 for “DUST” locations.
- Use NEMA 4X for outdoor locations, rooms below grade (including basements and buried vaults), damp, wet locations, and corrosive. Enclosures shall be Type 316 stainless steel.

- Use NEMA 7 for classified hazardous areas as per NEC. Class, Division and Group shall be determined during detailed design.

Concrete-encased duct banks will be provided for selected major underground conduit installations, generally for large feeders and/or multi-conductor cables between structures. Marking tape will be used above concrete-encased duct banks and direct buried conduits.

Underground electrical conduits will be placed at least 24 inches below grade. Working clearances between underground electrical utilities and other non-electric underground utilities should be 12 inches (minimum) in addition to other specific equipment requirements.

Motor starters will be NEMA rated. IEC rated starters will not be acceptable.

Transformer winding will be copper. Aluminum windings will not be acceptable.

All electrical equipment and materials shall be UL listed and shall bear the appropriate UL listing mark or classification marking. Equipment, materials, etc. utilized not bearing a UL certification shall be field or factory UL certified prior to equipment acceptance and use.

All electrical work will be designed in accordance with the latest editions of the NEC and Local Electrical Codes.

5.7.11 Preferred Manufacturers of Major Equipment

This list will be further coordinated with the City during final design.

- Square D (pad mount transformers, Motor Control Centers, Panelboards and Dry Type lighting Transformers)
- Cutler-Hammer (pad mount transformers, Motor Control Centers, Panelboards and Dry Type lighting Transformers)
- General Electric (pad mount transformers, Motor Control Centers, Panelboards and Dry Type lighting Transformers)

5.8 Site Security

During a project status meeting in November, the City expressed interest in adding a security system with motion sensing cameras on site as part of the project improvements. The cost of these systems varies based on the number of cameras and the amount of available light in the locations where cameras are to be added. For the PER, CDM Smith included cost for a power and fiber optic loop around the perimeter of the site along with 15 cameras. It is recommended that during the final design, CDM Smith and the City coordinate on exact locations for cameras to more accurately determine the cost and scope of the proposed site security system. A fence will be installed around the plant perimeter to enclose the site and provide an additional layer of security. Security cameras, recording software, and lighting will be upgraded to provide effective surveillance.

5.9 Maintenance of Plant Operations

Maintenance of plant operations (MOPO) during construction is a critical element to this project. A MOPO plan will be required to be developed by the general contractor, however, a suggested MOPO plan is provided in this section.

In order to replace the mud valves and repair the interior concrete of the PAA contact basin (formerly chlorine contact basin) each side must be isolated from flow. Due to difficulties in performing the work on the contact basin presented by the common mixing chamber, new mixing chambers will be constructed inside the contact basin trains themselves. For example, the isolation gates on the north side of the basin will be closed to isolate the north train. While it is out of service, the new mixing chamber will be constructed with new slide gates, mud valves will be replaced, and any concrete repair and coating work will be performed. Once work is completed, the existing isolation gates will be opened and either removed or abandoned in place. Isolation of this train will be completed using the new slide gates. The north side of the basin will be brought back into service and the process will be repeated for the south side of the basin to complete the work. This will allow for the plant to remain in service while work on the basin is being done without having to rely on low flow timing, bypass pumping, and work inside the existing mixing chamber.

Modification to the former chlorine building (renamed the PAA building) will be required. Because the chlorination equipment was not installed, impacts to maintenance of plant operations are less than with the contact tank. The preliminary mechanical layout indicates minimal conflict with existing facilities in the PAA building.

Section 6

Opinion of Probable Cost and Schedule

6.1 Opinion of Probable Construction Cost

Using the disinfection results obtained during pilot testing, this section provides a description of the additional assumptions necessary to derive a preliminary opinion of probable construction cost (OPCC) for PAA disinfection including the bulk storage, delivery, and management of the PAA systems.

The American Association of Cost Engineers (AACE) defines three levels of cost estimates—1) order-of-magnitude, 2) budgetary and 3) definitive—each of which is applicable at a different stage of a project. The OPCC presented in this section is intended to represent budgetary (level 2) estimates as defined by AACE, with estimates being made without detailed engineering data. The estimates rely on the use of previous estimates and historical data from comparable work, estimating guides, handbooks and costing curves, and manufacturer supplied equipment costs. Costs are given in current (2014) dollars without escalation. The actual cost of any project will depend on actual labor and material costs for competitive bids, project complexity, competitive market condition, actual site conditions, final scope of work, implementation schedule, continuity of personnel and engineering. A summary of the OPCC is provided in **Appendix E**.

The Opinion of Probable Construction Cost (OPCC) is $4.8 million and was developed based on the drawings and includes the following key assumptions:

- 25-percent construction contingency, 10-percent general conditions, and 12-percent contractor overhead and profit
- The containment area is slab-on-grade and no deep foundations are required
- The PAA Provider provides the PAA tanks, feed pump, transfer pumps, off-loading pump, motor control center, PLC and controls, mixer(s), air compressor and piping for the system. The General Contractor installs the equipment under the supervision of a representative of the PAA provider.
- No lead-based paint or asbestos removal is required inside the building
- 15 site security cameras and a fiber optic loop were assumed for the estimated cost of the site security system

6.2 Project Schedule

Upon approval of the preliminary design provided in this report, final design is anticipated to require approximately 8 months (completed by late August 2014). Following approval by Memphis and the State of Tennessee, bidding will commence and is anticipated to require 4 months from advertisement to final award and Notice to Proceed (NTP) to the contractor. Construction of the PAA system improvements is estimated to require up to 15 months from notice to proceed to final completion, with an additional 2 months for final start-up and full operation. The overall project schedule is shown in **Appendix F**.

Appendix A

VigorOx WWT II Materials Safety Data Sheets

MATERIAL SAFETY DATA SHEET

VigorOx® WWT II

MSDS Ref. No.: 79-21-0-27
Date Approved: 04/10/2009
Revision No.: 2

This document has been prepared to meet the requirements of the U.S. OSHA Hazard Communication Standard, 29 CFR 1910.1200 and Canada's Workplace Hazardous Materials Information System (WHMIS) requirements.

1. PRODUCT AND COMPANY IDENTIFICATION

PRODUCT NAME:	VigorOx® WWT II
SYNONYMS:	Peroxyacetic Acid, Acetyl Hydroperoxide
GENERAL USE:	Wastewater and sewage effluent disinfection.
	EPA Registration No. 65402-8

MANUFACTURER

FMC CORPORATION
FMC Peroxygens
1735 Market Street
Philadelphia, PA 19103
(215) 299-6000 (General Information)
msdsinfo@fmc.com (Email - General Information)

EMERGENCY TELEPHONE NUMBERS

(303) 595-9048 (Medical - U.S. - Call Collect)

For leak, fire, spill, or accident emergencies, call:
(800) 424-9300 (CHEMTREC - U.S.A. & Canada)

2. HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW:

- Clear liquid with a sharp, pungent, vinegar-like odor.
- Oxidizer.
- Stabilized peracetic acid, an ingredient in this product, decomposes under fire conditions to release oxygen that intensifies the fire.
- Use water to keep fire exposed containers cool.
- Severely irritating to skin and eyes.

POTENTIAL HEALTH EFFECTS: Liquid and mist are corrosive (causing burns); direct contact could cause irreversible damage to eyes including blindness and/or irreversible destruction of skin tissue. Vapor/mist will irritate nose, throat and lungs but will usually subside when exposure ceases.

3. COMPOSITION / INFORMATION ON INGREDIENTS

Chemical Name	CAS#	Wt.%	EC No.	EC Class
Peroxyacetic Acid	79-21-0	15	201-186-8	O, C, Xn, N; R7-R10-R20/21/22-R35-R50
Hydrogen Peroxide	7722-84-1	23	231-765-0	O, C, Xn; R5- R8-R20/22-R35
Acetic Acid	64-19-7	16	200-580-7	C; R10-35
Sulfuric Acid	7664-93-9	1	231-639-5	C; R35
Water	7732-18-5	45	231-791-2	Not classified

4. FIRST AID MEASURES

EYES: Immediately flush with water for at least 15 minutes, lifting the upper and lower eyelids intermittently. See a medical doctor or ophthalmologist immediately.

SKIN: Immediately flush with plenty of water while removing contaminated clothing and/or shoes, and thoroughly wash with soap and water. Obtain immediate medical attention. Contact a medical doctor if necessary.

INGESTION: Rinse mouth with water. Dilute by giving 1 or 2 glasses of water. Do not induce vomiting. Never give anything by mouth to an unconscious person. See a medical doctor immediately.

INHALATION: Remove to fresh air. If breathing discomfort occurs and persists, see a medical doctor. If breathing has stopped, give artificial respiration and see a medical doctor immediately.

NOTES TO MEDICAL DOCTOR: This product can be corrosive to skin, eyes and mucous membranes. Consideration should be given to careful endoscopy as stomach or esophageal burns, perforations or strictures may occur. Careful gastric lavage with an endotracheal tube in place should be considered. Observation may be warranted. Treatment is controlled removal of exposure followed by symptomatic and supportive care.

5. FIRE FIGHTING MEASURES

EXTINGUISHING MEDIA: Use water to keep fire exposed containers cool.

FIRE / EXPLOSION HAZARDS: Decomposition releases oxygen that can initiate or promote combustion.

FIRE FIGHTING PROCEDURES: Use flooding quantities of water only. Use water spray to keep fire exposed containers cool. Fight fire from protected location or maximum distance. Chemical type extinguishers are not effective with peracetic acid or hydrogen peroxide, which are ingredients in this product. Use proper personal protective equipment and positive pressure self contained breathing apparatus.

FLAMMABLE LIMITS: Not available

SENSITIVITY TO IMPACT: Not available

SENSITIVITY TO STATIC DISCHARGE: Not available

---

6. ACCIDENTAL RELEASE MEASURES

RELEASE NOTES: Approach release from upwind. Stop or control leak using special protective clothing and positive pressure self-contained breathing apparatus. Control run off and isolate discharged material for proper disposal. Do not allow undiluted material to enter storm or sanitary sewer systems.

Combustible materials exposed to hydrogen peroxide, an ingredient in this product, should be immediately submerged in, or rinsed with, large amounts of water to ensure that all hydrogen peroxide is removed. Residual hydrogen peroxide that is allowed to dry (upon evaporation hydrogen peroxide can concentrate) on organic materials such as paper, fabrics, cotton, leather, wood or other combustibles can cause the material to ignite and result in a fire.

---

7. HANDLING AND STORAGE

HANDLING: General - Transfer product from drums (IBC) to process in closed system (hermetically) and if not possible use effective local exhaust ventilation.

Drums - Empty as thoroughly as possible. Triple rinse drum before disposal. Avoid contamination; impurities accelerate decomposition. Never return product to original container.

IBCs (Tote) - IBCs should be emptied as thoroughly as possible and returned without rinsing.

STORAGE: Do not store near reducing agents, fuels or other non-compatible materials. Store in a cool (less than 86°F), dry, well ventilated area. Do not store in direct sunlight, or near sources of ignition or heat. Do not double stack. Use first in, first out storage system. Containers must be vented.

COMMENTS: VENTILATION: Provide mechanical local exhaust ventilation to prevent release of mist into the work area. If ventilation is inadequate or not available use acid gas cartridge or canister with full face-piece.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

EXPOSURE LIMITS

Chemical Name	ACGIH	OSHA	Supplier
Hydrogen Peroxide	1 ppm (TWA)	1 ppm (PEL)	
Acetic Acid	15 ppm (STEL)	10 ppm (PEL)	
Sulfuric Acid	2 mg/m^3 (STEL)	1 mg/m^3 (TWA)	

ENGINEERING CONTROLS: Provide mechanical local exhaust ventilation to prevent release of mist into the work area. If release is expected use respiratory protection.

PERSONAL PROTECTIVE EQUIPMENT

EYES AND FACE: Use cup type chemical goggles. Full face shield may be used.

RESPIRATORY: Use approved acid/gas cartridge or canister with full face-piece unless break-through occurs, then use airline supplied or self contained breathing apparatus with full face-piece.

PROTECTIVE CLOTHING: Rubber or neoprene footwear. Rubber or neoprene aprons or full protective clothing. Hydrogen peroxide is an ingredient in this product; completely submerge hydrogen peroxide contaminated clothing or other materials in water prior to drying. Residual hydrogen peroxide, if allowed to dry on materials such as paper, fabrics, cotton, leather, wood or other combustibles can cause the material to ignite and result in a fire.

GLOVES: Rubber or neoprene gloves. Thoroughly wash the outside of gloves with soap and water prior to removal. Inspect regularly for leaks.

9. PHYSICAL AND CHEMICAL PROPERTIES

ODOR:	Sharp, pungent, vinegar like odor
APPEARANCE:	Colorless liquid
AUTOIGNITION TEMPERATURE:	270 °C (518 °F)
BOILING POINT:	About 108 °C (226 °F)
COEFFICIENT OF OIL / WATER:	Not available
DENSITY / WEIGHT PER VOLUME:	9.7 lb/gal @ 20 °C
EVAPORATION RATE:	Above 1 (Butyl Acetate = 1)

FLASH POINT:	About 68 °C (154 °F) (CC) Open Cup - No measurable flash point up to 110°C. Fire Point - No fire point. This material will not sustain a flame.
MELTING POINT:	-49 °C (-56 °F)
ODOR THRESHOLD:	Not available
OXIDIZING PROPERTIES:	Strong oxidizer
PERCENT VOLATILE:	99
pH:	Less than 1
SOLUBILITY IN WATER:	100 % @ 25 °C (by wt.)
SPECIFIC GRAVITY:	1.16 @ 20 °C (H_2O=1)
VAPOR DENSITY:	Not available (Air = 1)
VAPOR PRESSURE:	22 mm Hg @ 25 °C (77 °F)

COMMENTS:

pH (1% solution) @ 25°C: 2-3
Self Accelerating Decomposition Temperature (SADT) > 55°C (55 gallon drum)

10. STABILITY AND REACTIVITY

CONDITIONS TO AVOID:	Open flames, elevated temperatures (> 86°F), any source of heat, combustibles such as paper and wood and contamination.
STABILITY:	Stable (contamination or heat could initiate decomposition).
POLYMERIZATION:	Will not occur
INCOMPATIBLE MATERIALS:	Dirt, alkali (caustic), reducing agents, oxidizing agents, organics and heavy metals such as iron, copper, chromium, nickel, aluminum and cobalt.
HAZARDOUS DECOMPOSITION PRODUCTS:	Acetic acid and oxygen that supports combustion.

11. TOXICOLOGICAL INFORMATION

EYE EFFECTS: Severely irritating, corrosive (rabbit) [FMC Study I83-719]

SKIN EFFECTS: Severely irritating, corrosive (rabbit) [FMC Study I83-720]

DERMAL LD_{50}: > 200 mg/kg (rabbit) [FMC Study I83-721]

ORAL LD_{50}: No data available for the product.
35% Peracetic Acid: 50 - 500 mg/kg [FMC Study I86-935]

INHALATION LC_{50}: No data available for the product.
5% Peracetic Acid: 4,080 mg/m^3 (4157 ppm) (4 h) (rat) [FMC Study I96-2138]
100% Peracetic Acid: 204 mg/m^3 (66 ppm) (4 h) (rat) [FMC Study I96-2138]

TARGET ORGANS: Eyes, skin, nose, throat, lungs

ACUTE EFFECTS FROM OVEREXPOSURE: No data available for the product. Liquid may cause severe burns and irreversible tissue damage to eyes, including blindness. Inhalation of peracetic acid vapors causes lacrimation and irritation of the mucous membranes, eyes and nasal passages.

CHRONIC EFFECTS FROM OVEREXPOSURE: No data available for the product. The International Agency for Research on Cancer (IARC) has concluded that there is inadequate evidence for carcinogenicity of hydrogen peroxide in humans, but limited evidence in experimental animals (Group 3 - not classifiable as to its carcinogenicity to humans). The American Conference of Governmental Industrial Hygienists (ACGIH) has concluded that hydrogen peroxide is a 'Confirmed Animal Carcinogen with Unknown Relevance to Humans' (A3). Repeated inhalation of the mist may cause inflammation of the upper respiratory tract, chronic bronchitis and etching of the dental enamel. Persons who are asthmatics may be more sensitive to the effects of inhaled acid sulfates. The International Agency for Research on Cancer (IARC) has concluded that occupational exposure to strong inorganic acid mists containing sulfuric acid are carcinogenic to humans (Group 1). The American Conference of Governmental Industrial Hygienists (ACGIH) has concluded that sulfuric acid, contained in strong inorganic acid mists, is a 'Suspected Human Carcinogen' (A2 - limited evidence of carcinogenicity in humans and sufficient evidence of carcinogenicity in experimental animals with relevance to humans).

CARCINOGENICITY:

Chemical Name	IARC	NTP	OSHA	Other
Hydrogen Peroxide	3	Not listed	Not listed	(ACGIH) A3
Sulfuric Acid	1 (strong inorganic acid mists containing sulfuric acid)	Known carcinogen (strong inorganic mists containing sulfuric acid)	Not listed	(ACGIH) A2 (when contained in strong inorganic acid mists)

12. ECOLOGICAL INFORMATION

ECOTOXICOLOGICAL INFORMATION: No data available for the product.

96-hour LC_{50} = 1.6 mg/L (Rainbow trout) [FMC I95-2023]
96-hour LC_{50} = 1.1 mg/L (Bluegill sunfish) [FMC I95-2029]
48-hour EC_{50} = 0.73 mg/L (Daphnia magna) [FMC I95-2021]
120-hour EC_{50} = 0.18 mg/L (Selenastrum, green algae) [FMC I95-2027]

CHEMICAL FATE INFORMATION: No data available for the product. Peracetic acid is completely miscible with water. Aqueous solutions of peracetic acid hydrolyze to acetic acid and hydrogen peroxide.

13. DISPOSAL CONSIDERATIONS

DISPOSAL METHOD: Discharge as a hazardous waste into a suitable treatment system in accordance with local, state and federal governmental agencies.

14. TRANSPORT INFORMATION

U.S. DEPARTMENT OF TRANSPORTATION (DOT)

PROPER SHIPPING NAME:	Organic Peroxide Type F, Liquid (<=17% Peracetic Acid with <= 26% Hydrogen Peroxide)
PRIMARY HAZARD CLASS / DIVISION:	5.2 (Organic Peroxide)
HAZARD CLASS, SUBSIDIARY:	8 (Corrosive)
UN/NA NUMBER:	UN 3109
PACKING GROUP:	II
LABEL(S):	5.2 Organic Peroxide and Subsidiary Risk - 8 (Corrosive)
PLACARD(S):	5.2 Organic Peroxide
MARKING(S):	Organic Peroxide Type F, Liquid (with <= 17% Peracetic Acid with <= 26% Hydrogen Peroxide), UN 3109
REPORTABLE QUANTITY (RQ):	Not applicable
ADDITIONAL INFORMATION:	49 STCC Number: Not applicable Material is shipped in 5 gal. (45 lb.), 30 gal. (250 lb.) and 55 gal. (450 lb.) vented linear (not cross linked) polyethylene containers, as well as linear (not cross linked) polyethylene IBC's (300 gal.). Do not ship on wooden pallets.

INTERNATIONAL MARITIME DANGEROUS GOODS (IMDG)

PROPER SHIPPING NAME:	Organic Peroxide Type F, Liquid (with <= 17% Peracetic Acid with <= 26%

Hydrogen Peroxide)

INTERNATIONAL CIVIL AVIATION ORGANIZATION (ICAO) / INTERNATIONAL AIR TRANSPORT ASSOCIATION (IATA)

PROPER SHIPPING NAME:	Organic Peroxide Type F, Liquid (with <= 17% Peracetic Acid with <= 26% Hydrogen Peroxide)
ADDITIONAL INFORMATION:	NOTE: Venting of packages is not permitted for air transport.

OTHER INFORMATION:

Dike any spills. Protect against damage. Use proper personal protective equipment and positive pressure self-contained breathing apparatus when handling spills or leaks.

Ship in refrigerated trucks at 45ºF.

If this material is ever shipped via vessel, containers require subsidiary placarding in addition to main hazard class placards.

---

15. REGULATORY INFORMATION

UNITED STATES

SARA TITLE III (SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT)

SECTION 302 EXTREMELY HAZARDOUS SUBSTANCES (40 CFR 355, APPENDIX A):
Listed

REPORTABLE QUANTITY:

Chemical Name	RQ
Peroxyacetic Acid	500 lb
Sulfuric Acid	1,000 lb

SECTION 311 HAZARD CATEGORIES (40 CFR 370):
Fire Hazard, Immediate (Acute) Health Hazard, Reactive

SECTION 312 THRESHOLD PLANNING QUANTITY (40 CFR 370):
The Threshold Planning Quantity (TPQ) for this product, if treated as a mixture, is 10,000 lbs; however, this product contains the following ingredients with a TPQ of less than 10,000 lbs.:
500 lb

SECTION 313 REPORTABLE INGREDIENTS (40 CFR 372):
Peracetic acid

CERCLA (COMPREHENSIVE ENVIRONMENTAL RESPONSE COMPENSATION AND LIABILITY ACT)

CERCLA DESIGNATION & REPORTABLE QUANTITIES (RQ) (40 CFR 302.4):

15 % Peracetic Acid (Unlisted), RQ = 100 lbs., Ignitability, Corrosivity Listed

Chemical Name	RQ	
Acetic Acid	5,000 lb	Category D
Sulfuric Acid	1,000 lb	Category C

TSCA (TOXIC SUBSTANCE CONTROL ACT)

TSCA INVENTORY STATUS (40 CFR 710):

All components listed

RESOURCE CONSERVATION AND RECOVERY ACT (RCRA)

RCRA IDENTIFICATION OF HAZARDOUS WASTE (40 CFR 261):

Waste Number: D001 (ignitability), D002 (corrosivity)

CANADA

WHMIS (WORKPLACE HAZARDOUS MATERIALS INFORMATION SYSTEM):

This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations and the MSDS contains all the information required by the Controlled Products Regulations.

Hazard Classification / Division: C
E
D1A

Ingredient Disclosure List: Listed
Domestic Substance List: All components listed

INTERNATIONAL LISTINGS

Peroxyacetic acid:
Australia (AICS): Listed
China: Listed
Japan (ENCS): (2)-689
Philippines (PICCS): Listed

Hydrogen peroxide:
China: Listed
Japan (ENCS): (1)-419
Korea: KE-20204
Philippines (PICCS): Listed

Acetic acid:
Australia (AICS): Listed
China: Listed
Japan (ENCS): (2)-688
Korea: KE-00013

Sulfuric acid:
China: Listed
Japan (ENCS): (1)-430; (1)-724
Korea: KE-32570
Philippines (PICCS): Listed

HAZARD AND RISK PHRASE DESCRIPTIONS:

EC Symbols:	O	(Oxidizer)
	C	(Corrosive)
	Xn	(Harmful)
	N	(Dangerous for the environment)
EC Risk Phrases:	R5	(Heating may cause an explosion.)
	R7	(May cause fire)
	R8	(Contact with combustible material may cause fire)
	R10	(Flammable)
	R20/21/22	(Harmful by inhalation, in contact with skin and if swallowed.)
	R20/22	(Harmful by inhalation and if swallowed.)
	R35	(Causes severe burns.)
	R50	(Very toxic to aquatic organisms.)

16. OTHER INFORMATION

HMIS

Health	3
Flammability	1
Physical Hazard	2
Personal Protection (PPE)	H

Protection = H (Safety goggles, gloves, apron and a vapor respirator)

HMIS = Hazardous Materials Identification System

Degree of Hazard Code:
4 = Severe
3 = Serious
2 = Moderate
1 = Slight
0 = Minimal

NFPA

Health	3
Flammability	1
Reactivity	2
Special	OX

SPECIAL = OX (Oxidizer)

NFPA (National Fire Protection Association)

Degree of Hazard Code:
4 = Extreme
3 = High
2 = Moderate
1 = Slight
0 = Insignificant

REVISION SUMMARY:
This MSDS replaces Revision #1, dated April 9, 2009.
Changes in information are as follows:
Section 1 (Product and Company Identification)
Section 16 (Other Information)

VigorOx and FMC - Trademarks of FMC Corporation

FMC Corporation believes that the information and recommendations contained herein (including data and statements) are accurate as of the date hereof. NO WARRANTY OF FITNESS FOR ANY PARTICULAR PURPOSE, WARRANTY OF MERCHANTABILITY, OR ANY OTHER WARRANTY, EXPRESSED OR IMPLIED, IS MADE CONCERNING THE INFORMATION PROVIDED HEREIN. The information provided herein relates only to the specific product designated and may not be applicable where such product is used in combination with any other materials or in any process. It is a violation of Federal law to use this product in a manner inconsistent with its labeling. Further, since the conditions and methods of use are beyond the control of FMC Corporation, FMC Corporation expressly disclaims any and all liability as to any results obtained or arising from any use of the product or reliance on such information.

Appendix B

FMC Process Equipment Data

MEMPHIS WWTP – STILES
PREMILINARY ENGINEERING ABSTRACT
December 2, 2013 PEROXYGENS DIVISION

FMC has prepared a preliminary equipment selection for the installation of a bulk storage and handling system for VigorOx® WWTII. The system will provide the storage and delivery of VigorOx WWTII into the City of Memphis' Stiles wastewater treatment facility.

Selection Parameters

Required onsite storage: 136,000 gallons

Required VigorOx WWTII Delivery Capacity: 945 gal/h (15.8 gal/min)

Average VigorOx WWTII Delivery Capacity: 205 gal/h (3.4 gal/min)

The proposed storage system will include twelve (12) Snyder 12,500 gallon double-wall HDLPE storage tanks. The tanks will be filled from the top of the tank via a 1.5 inch stainless steel line. During filling a 1.5 inch stainless steel vapor return manifold will route peracetic acid vapors back to the unloading truck creating a closed loop system. The vapor return manifold will connect back to the unloading truck via a 2 inch hose.

The trucks will be unloaded using a Wilden P400 AOD unloading pump. An automated switching system with electrically actuated valves (Kitz K150 with EXH actuator) will select which tank will be filled. An installed spare unloading pump will be included.

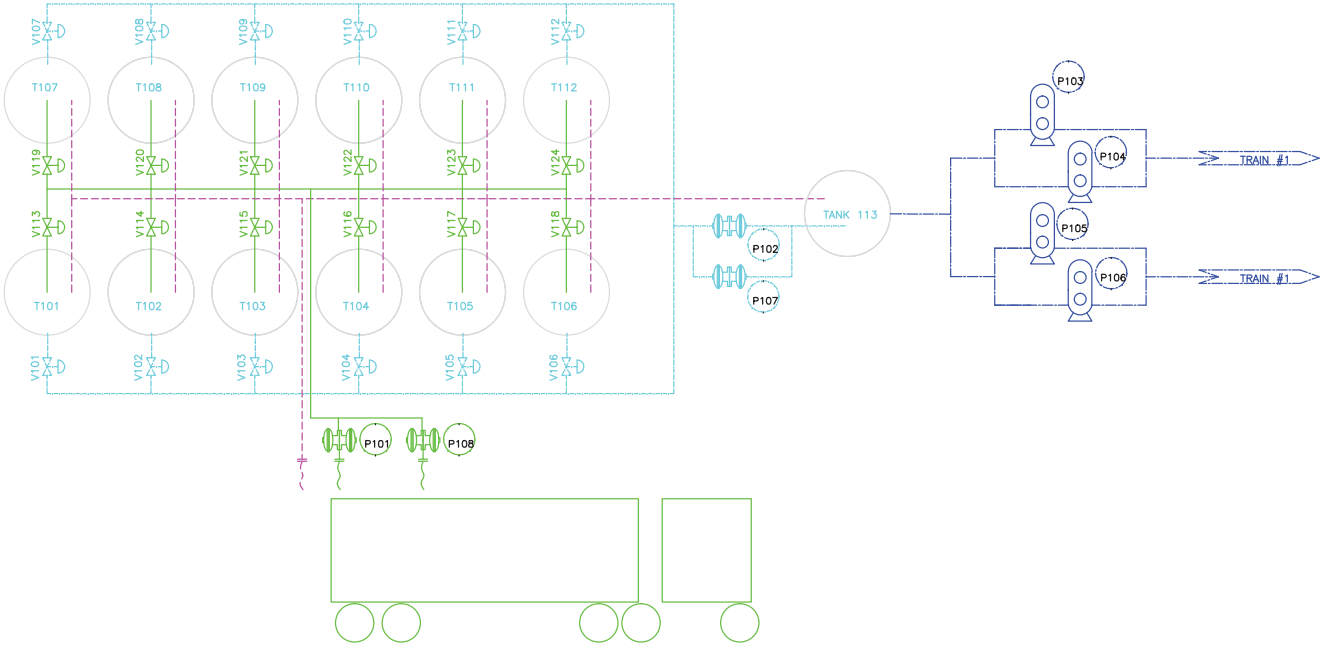
The tanks will be equipped with an Endress-Hauser FMR240 guided radar level transmitter and a Seimens CLS200 series high-high conductivity level switch. For normal breathing the tanks will be equipped with pressure/vacuum conservation vents.

The tanks will unload from a sidewall installed 2 inch nozzle and feed a manifold that will gravity supply the Wilden P400 AOD transfer pumps. The transfer pumps will feed one (1) Snyder 2,500 gallon double-wall HDLPE storage day tank. The day tank will be filled from the top. The tanks will unload from the bottom and gravity feed the VigorOx WWTII dosing pumps.

The VigorOX WWTII dosing pumps will be gear pumps (Pulsafeeder Isochem or similar). The pumps will treat the single treatment train at the plant. A single pump will run under normal operation with an installed spare. An additional pump and installed spare will accommodate the dosing requirements under peak flow conditions. FMC is currently reviewing mixing and injections systems to best to suit the requirements of the plant. We will update as soon as a selection has been made.

PIPING DESCRIPTION (ALL SCH40 304L	SIZE (IN)
SS) VAPOR RECOVERY	1.5
DOSING LINE	3/4
DELIVERY FILL LINE	1.5
TRANSFER LINE	1.5

T101–112 12500 GALLON SNYDER DOUBLE WALL CAPTOR TANK	P101 VIGOROX WWTII UNLOADING AOD PUMP WILDEN P400 FLOWS:50–80gpm	P102 VIGOROX WWTII TRANSFER AOD PUMP WILDEN P400 FLOWS:50–80gpm	P103 VIGOROX WWTII DOSING PUMP PULSAFEEDER ISOCHEM FLOWS:1–10gpm	P104 VIGOROX WWTII DOSING PUMP PULSAFEEDER ISOCHEM FLOWS:1–10gpm	P107 VIGOROX WWTII TRANSFER AOD PUMP WILDEN P400 INSTALLED SPARE FLOWS:50–80gpm
T113 2500 GALLON SNYDER DOUBLE WALL DAY TANK	V101–V112 AUTOMATED VALVE VIGOROX WWTII FILLING	V113–V124 AUTOMATED VALVE VIGOROX WWTII TRANSFER	P105 VIGOROX WWTII INSTALLED SPARE DOSING PUMP PULSAFEEDER ISOCHEM FLOWS:1–10gpm	P106 VIGOROX WWTII INSTALLED SPARE DOSING PUMP PULSAFEEDER ISOCHEM FLOWS:1–10gpm	P108 VIGOROX WWTII UNLOADING AOD PUMP WILDEN P400 INSTALLED SPARE FLOWS:50–80gpm



ENGINEER: ES

FMC Corporation
Technical Service Engineering
Box 845, Buffalo, New York 14240

DRN: EJS
DATE: 11/27/13
SCALE: NONE

MEMPHIS STILES PRELIMINARY PFD

REV.	DESCRIPTION	DATE

DRAWING NO. MEMPHIS STILES PRELIMINARY PFD REV. 0

Snyder Industries, Inc.
Specification #199901 For
Polyethylene Upright Double Wall Storage Tanks
(10-19-2012)

1. Scope

1.1 This specification covers upright, double wall, flat bottom storage tank assemblies. The assembly consists of one cylindrical inner primary tank and one blended form octagonal outer secondary tank. Each tank is molded in one-piece seamless construction by rotational molding (laminated or fabricated tanks will not be accepted). The tanks are designed for above-ground, vertical installation and are capable of containing chemicals at atmospheric pressure. The assembly shall be designed to prevent rainwater from entering the containment tank. The design shall allow direct primary tank base retention for up to seismic conditions per IBC code requirements. The containment tank shall be designed to hold a minimum of 115% of the normal fill capacity of the primary tank. Included in this specification are requirements for material properties, design, construction, dimensions, tolerances, workmanship, and appearance. Tank capacities are from 550 gallons (2082 L) up to 10,000 gallons (37,851 L).

1.2 This specification does not cover the design of vessels intended for use at pressures above or below atmospheric conditions. It is also not for vessels intended for use with liquids heated above their flash points, temperatures above 140 degrees Fahrenheit for Type I materials, or temperatures above 130 degrees Fahrenheit for Type II materials (see section 6.1 for material classifications).

2. Applicable Documents

2.1 ASTM (American Society for Testing and Materials) Standards:

D618 Conditioning Plastics and Electrical Insulating Materials for Testing
D638 Tensile Properties of Plastics
D790 Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
D883 Definitions of Terms Relating to Plastics
D1505 Density of Plastics by the Density-Gradient Technique
D1525 Test Method for Vicat Softening Temperature of Plastics
D1693 Test Method for Environmental Stress-Cracking of Ethylene Plastics
D1998 Standard Specification for Polyethylene Upright Storage Tanks
D2765 Degree of Crosslinking in Crosslinked Ethylene Plastics as Determined by Solvent Extraction
D2837 Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials
D3892 Practice for Packaging/Packing of Plastics
F412 Definitions of Terms Relating to Plastic Piping Systems

2.2 ARM (Association of Rotational Molders) Standards: Low Temperature Impact Resistance (Falling Dart Test Procedure)

2.3 ANSI Standards: B-16.5 Pipe Flanges and Flanged Fittings

2.4 OSHA Standards: 29 CFR 1910.106 Occupational Safety and Health Administration, Flammable and Combustible Liquids

2.5 UBC CODE: Uniform Building Code 2006 Edition

2.6 IBC CODE: International Building Code 2009 Edition

2.7 CBC Code: California Building Code 2010 Edition

2.8 NSF/ANSI Standard 61 – Drinking Water System Components (Type II resin)

2.9 40 CFR-264.193

3. Submittals

3.1 Drawings and Data: The manufacturer's shop drawings shall be approved by the engineer or contractor prior to the manufacturing of the tank(s). Data and specifications for the equipment shall include, but shall not be limited to the following.

3.2 Contractor shall submit for review sufficient literature, detailed specifications, and drawings to show dimensions, materials used, design features, internal construction, weights and any other information required by the ENGINEER for review of storage tanks and accessories.

3.3 Information to be included with submittals are specified below:

3.3.1 Shop drawings for the tanks shall include as a minimum the following:

a) Service Conditions: Chemical environment and temperature.

b) Statement that fabrication shall be in accordance with ASTM D 1998, where applicable.

c) Sizing and description of the fittings and accessories for each tank that are to be supplied by the tank manufacturer.

d) Layouts and assembly schedules for each tank identifying the location and elevation from the bottom of the tank for all connections and appurtenances supplied by the tank manufacturer.

3.3.2 Resin - A copy of the resin data sheet from the resin manufacturer for the tank is to be supplied and the tank manufacturer is to certify that it will be the resin used in the manufacture of the tank. Verification may be required if the resin is to be FDA or NSF 61 listed.

3.3.3 Wall thickness - Prior to the manufacture of the tank the designed wall thickness audit is to be supplied based upon 600 psi hoop stress (ASTM D 1998) @ 100 degrees F. (Note: See 7.1.2 for chemicals being stored above 100 degrees F)

3.3.4 Tank restraint – If supplied, the drawings and calculations for the system are to be provided. Note: Wet stamped or site specific drawings and calculations may be required.

3.3.5 Supporting information on fittings and accessories to be supplied; heat system, insulation, mastic coating, etc.

3.4 Technical Manuals: The tank manufacturer's "Guideline for Use & Installation" is to be submitted for review.

3.5 Installation certificate: Once installed the installer is to certify that the tank system has been installed according to the tank manufacturer's Guidelines for Use & Installation.

3.6 Manufacturer's warranty

3.7 Manufacturer Qualifications: The manufacturer is to have rotationally molded polyethylene tanks based upon ASTM D 1998 utilizing Type I and Type II resins for the last 10 years.

3.8 Factory Test Report: Upon completion of the tank the manufacturer's inspection report is to be supplied for each tank.

a. Verification of wall thickness (See 8.5)
b. Impact test (See 8.3.1)
c. Gel test – (Type I resin only) (See 8.4)
d. Hydrostatic test (See 8.6)
e. Verification of fitting placement (See 8.2.4)
f. Visual inspection (See 8.7)
g. Verification of materials

4. Service Conditions

Note: The tank color will be based upon the chemical application and UV exposure of the installation. Tank color is to be natural, black or opaque white.

Table I – Service Conditions

Tank #	Chemical Stored	Concentration / Specific Gravity	Tank Location Inside / Outside	Operating Temperature *(Temperature of chemical)*	Fitting Material	Gasket Material	Bolt Material

5. Chemical Compatibility

5.1 Chemical compatibility shall be according to the following chemical resistance guides:

Compass Publications -

Pruett, Kenneth M., "Chemical Resistance Guide for Plastics"

Pruett, Kenneth M., "Chemical Resistance Guide for Metals and Alloys"

Pruett, Kenneth M., "Chemical Resistance Guide for Elastomers III"

5.2 These references shall be considered as general guidelines only. In many cases, combinations of these chemicals are used in such a way that only the customer (by testing molded product samples) can make a determination in regards to acceptability.

Note: Contact the manufacturer for applications that are not listed below.

Chemical	Concentration	Resin	Design Info	Fitting Material	Gasket Material	Bolt Material
Acetic Acid	60	HDLPE & XLPE	1.5/600	PP/PVC	EPDM	316SS/Hastelloy/Titan.
Acetic Acid	80	HDLPE	1.9/600	PP	EPDM	316SS/Hastelloy/Titan.
Acrylic Emulsions	50	XLPE	1.9/600	PVC	EPDM	316SS
Aluminum Sulfate	50	HDLPE & XLPE	1.5/600	PVC	EPDM	316SS**/Hastelloy/Titan.
Ammonium Sulfate	40	HDLPE & XLPE	1.5/600	PVC	EPDM	316SS**/Hastelloy/Titan.
Calcium Carbonate	Saturated	HDLPE & XLPE	1.9/600	PVC	EPDM	316SS

Calcium Chloride	40	HDLPE & XLPE	1.5/600	PVC	EPDM	316SS**/Hastelloy/Titan.
DEF (Diesel Exhaust Fluid)	32.5	HDLPE & XLPE	1.35/600	PP/PVC	EPDM	316SS
Deionized Water <5 Megohm		HDLPE & XLPE	1.5/600	PVC	EPDM	316SS
Deionized Water >5 Megohm		HDLPE & XLPE	1.5/600	PVC	EPDM	316SS
Ethyl Alcohol	100	HDLPE & XLPE	1.5/600	PVC	EPDM	316SS
Ethylene Glycol	100	HDLPE & XLPE	1.9/600	PVC	EPDM	316SS
Ferric Chloride	50	HDLPE & XLPE	1.9/600	PVC	EPDM	Hastelloy/Titan.
Ferric Sulfate	60	HDLPE & XLPE	1.9/600	PVC	EPDM	316SS**/Hastelloy/Titan.
Ferrous Chloride	Saturated	HDLPE & XLPE	1.9/600	PVC	EPDM	Hastelloy/Titan.
Ferrous Sulfate	20	HDLPE & XLPE	1.5/600	PVC	EPDM	Hastelloy
Hydrochloric Acid	37	HDLPE	1.9/600	PVC	Viton	Hastelloy
Hydrofluoric Acid	48	HDLPE	1.9/600	PP/PVC	Viton	Hastelloy
Hydrofluosilicic Acid	26	HDLPE/XLPE*	1.9/600	PP/PVC	Viton	Hastelloy
Hydrogen Peroxide	50	HDLPE	1.9/600	PVC	Viton	316SS/Hastelloy/Titan.
Isopropyl Alcohol	100	HDLPE & XLPE	1.5/600	PVC	EPDM	316SS
Magnesium Chloride	30	HDLPE & XLPE	1.5/600	PVC	EPDM	316SS**/Hastelloy/Titan.
Methyl Alcohol	100	HDLPE & XLPE	1.5/600	PVC	EPDM	316SS
Motor Oil	100	HDLPE & XLPE	1.9/600	316SS	Viton	316SS
Phosphoric Acid	85	HDLPE	1.9/600	PVC	Viton	316SS
Phosphoric Acid	50	HDLPE	1.9/600	PVC	Viton	316SS
Polymers (Deposition)		XLPE	1.5/600	PVC	EPDM	316SS
Potable Water		HDLPE	1.5/600	PVC	EPDM	316SS
Potassium Carbonate	50	HDLPE & XLPE	1.9/600	PVC	EPDM	316SS
Potassium Hydroxide	Saturated	HDLPE & XLPE	1.9/600	PVC	EPDM	316SS
Sodium Carbonate	30	HDLPE & XLPE	1.5/600	PVC	EPDM	316SS**/Hastelloy/Titan.
Sodium Carbonate	Saturated	HDLPE & XLPE	1.9/600	PVC	EPDM	316SS**/Hastelloy/Titan.
Sodium Hydroxide	50	HDLPE & XLPE	1.9/600	PVC	EPDM	316SS
Sodium Hypochlorite-in(Non-UV)	<16.5	HDLPE	1.9/600	PVC	Viton	Titanium
Sodium Hypochlorite-out (UV)	<16.5	HDLPE #880059	1.9/600	PVC	Viton	Titanium
Sodium Hypochlorite-out (UV)	<16.5	HDLPE Insulated	1.9/600	PVC	Viton	Titanium
Sodium Thiosulfate	40	HDLPE & XLPE	1.9/600	PVC	EPDM	316SS
Sulfuric Acid	98	HDLPE #880046*	1.9/600	CPVC	Viton	Hastelloy
Sulfuric Acid	93	HDLPE #880046*	1.9/600	CPVC	Viton	Hastelloy
Surfactants		XLPE	1.5/600	PVC	EPDM	316SS
Urea Solution	50	HDLPE & XLPE	1.35/600	PP/PVC	EPDM	316SS
Water w/Ozone up to 10 PPM		HDLPE & XLPE	1.5/600	PVC	EPDM	316SS

Note: Ambient Temperature / atmospheric pressure.
Chart applies to Industrial ASTM designed tanks.
*Chemical may cause tank material to discolor.
** 316SS may pit upon drying. Not recommended for SUMOs.
High purity chemical applications are limited to natural tank color or special hot compounded resins.
For chemicals or chemical blends not listed on the above chart, please contact Snyder Industries.

6. Materials – Resin Classification

6.1 Tanks are classified according to type as follows and it is the responsibility of the purchaser to specify Type I or Type II.

6.1.1 Type I – Tanks molded from cross-linkable polyethylene resin.

6.1.2 Type II - Tanks molded from linear polyethylene resin (not cross-linkable resin).

6.2 The material used shall be virgin polyethylene resin as compounded and certified by the manufacturer. Type I tanks shall be made from crosslinked polyethylene (XLPE) resin as manufactured by ExxonMobil Chemical, or resin of equal physical and chemical properties. Type II tanks shall be made from high density linear polyethylene (HDLPE) resin as manufactured by ExxonMobil Chemical, or resin of equal physical and chemical properties.

6.3 All polyethylene resin material shall contain a minimum of a U.V. 8 stabilizer as compounded by the resin manufacturer. Pigments may be added at the purchaser's request, but shall not exceed 0.25% (dry blended) of the total weight.

6.4 Mechanical Properties of Type I tank material: Cross-linked (XLPE)

PROPERTY	ASTM	VALUE
Density (Resin)	D1505	0.938-0.946 g/cc
Tensile (Yield Stress 2"/min)	D638	2830 - 3000 PSI
Elongation at Break (2"/min.)	D638	700 - 800%
ESCR (100% Igepal, Cond. A, F50)	D1693	>1000 hours
ESCR (10% Igepal, Cond. A, F50)	D1693	>1000 hours
Vicat Softening Degrees F. Temperature	D1525	250
Flexural Modulus	D790	87,000 – 110,000 PSI

6.5 Mechanical Properties of Type II tank material: High density Linear (HDLPE)

PROPERTY	ASTM	VALUE
Density (Resin)	D1505	0.941-0.948 g/cc
Tensile (Yield Stress 2"/min)	D638	3000 PSI
Elongation at Break (2"/min.)	D638	>1000%
ESCR (100% Igepal, Cond. A, F50)	D1693	550 hours
ESCR (10% Igepal, Cond. A, F50)	D1693	50 hours
Vicat Softening Degrees F. Temperature	D1525	235
Flexural Modulus	D790	130,000 PSI

7. Design Requirements

7.1 The minimum required wall thickness of the cylindrical shell at any fluid level shall be determined by the following equation, but shall not be less than 0.187 in. thick.

T = P x O.D./2 SD = 0.433 x S.G. x H x O.D./2 SD

T = wall thickness
SD = hydrostatic design stress, PSI
P = pressure (.433 x S.G. x H), PSI
H = fluid head, ft.
S.G. = specific gravity, g/cm^3
O.D. = outside diameter, in.

7.1.1 The hydrostatic design stress shall be determined by multiplying the hydrostatic design basis, determined by ASTM D2837 using rotationally molded samples, with a service factor selected for the application. The hydrostatic design stress is 600 PSI at 73 degrees

Fahrenheit for Type I and Type II materials. In accordance with the formula in 7.1, the tank shall have a stratiform (tapered wall thickness) wall.

7.1.2 The hydrostatic design stress shall be derated for service above 100 degrees Fahrenheit and for mechanical loading of the tank.

7.1.3 The standard design specific gravity shall be 1.5 or 1.9.

7.1 The minimum required wall thickness for the cylinder straight shell must be sufficient to support its own weight in an upright position without any external support. Secondary containment tanks shall be designed per SII standard containment thickness requirements. The secondary containment shall be configured to allow shipment of the primary tank inside of the secondary tank. The shipment shall be done without the aid of additional spacer blocks which can be lost during shipment causing tank damage.

7.2 The top head must be integrally molded with the cylinder shell. The minimum thickness of the top head shall be equal to the top of the straight wall. The primary tank top shall be configured to prevent rain water from entering the secondary containment tank. The top head of tanks with 550 or more gallons of capacity shall be designed to provide a minimum of 1300 square inches of flat area for fitting locations. The primary tank shall be keyed to the secondary tank preventing primary tank rotation. The secondary containment shall have 115% of the normal fill capacity of the primary tank.

7.3 Tanks with 550 or more gallons of capacity shall have a minimum of 3 lifting lugs integrally molded into the top head. The lifting lugs shall be designed to allow erection of empty primary and secondary tanks. Tanks shall be capable of being lifted into position as a unit (primary and secondary tanks).

7.4 The tank shall be designed to provide a minimum of 4 tie-down lugs integrally molded into the top head. The tie-down lugs shall be designed to allow tank retention in wind and seismic loading situations without tank damage. The primary/secondary tank unit shall be configured to allow direct primary tank base retention for seismic load conditions. The base retention unit shall be anchor bolted to an appropriate structure and not require additional spacer blocks. Refer to section 12.0 for tank tie-down accessories.

Table II – Tank Schedule

Tank Reference #				
Quantity				
Capacity - Side Wall				
Specific Gravity– designed				
Primary Tank				
Secondary Tank				
Diameter (nominal)				
Height (feet) maximum				
Tank Resin (primary/secondary)				
Type I XLPE				
Type II HDLPE				
Color				
Manway Type				

Fitting Material				
Gasket Material				
Bolt Material				

8. Test Methods

Quality Assurance & Testing

8.1 The tanks of the same material furnished under this Section shall be supplied by a manufacturer who has been regularly engaged in the design and manufacturing of rotationally molded polyethylene chemical storage tanks using cross-linked and high density linear polyethylene tanks for over ten years.

8.2 Dimensions and Tolerances

8.2.1 All dimensions will be taken with the tank in the vertical position, unfilled. Tank dimensions will represent the exterior measurements.

8.2.3 The tolerance for the outside diameter, including out of roundness, shall be per ASTM D1998.

8.2.4 The tolerance for fitting placements shall be +/- 0.5 in. in elevation and 2 degrees radial at ambient temperature.

8.3 Test Methods

Test specimens shall be taken from fitting location areas.

8.3.1 Low Temperature Impact Test

8.3.2 Test specimens shall be conditioned at (- 40) degrees Fahrenheit for a minimum of 2 hours.

8.3.3 The test specimens shall be impacted in accordance with the standard testing methods as found in ASTM D1998. Test specimens < ½" thickness shall be tested at 100 ft. lb. Test specimens > ½" thickness shall be tested at 200 ft. lb.

8.4 Degree of Crosslinking Test (% Gel – Type I Resin Only)

8.4.1 The test method used is to be the o-xylene insoluble fraction (gel test) per ASTM D2765 Method C. This test method is for determination of the ortho-xlene insoluble fraction (gel) of crosslinked polyethylene.

8.4.2 The percent gel level for Type I tanks on the inside 1/8 in. of the wall shall be a minimum of 65%.

8.5 Ultrasonic Tank Thickness Test

8.5.1 All tanks 2000 gallons or larger shall be measured for tank wall thickness at 6", 1ft., 2ft. and 3ft. on the tank sidewall height at 0° and 180° around the tank circumference with 0° being the tank manway and going counter-clockwise per ANSI standard drafting specifications. A copy of this test report can be ordered when placing the original tank order. All tanks shall meet design thickness requirements and tolerances.

8.5.2 Tanks smaller than 2000 gallons are only periodically measured at the start of a production run or after any design changes. Customers can place an order for tank wall

thickness measurements on smaller tank sizes when placing the original order. A copy of the test report will be provided if ordered.

8.6 Hydrostatic Water Test

8.6.1 The hydrostatic water test shall consist of filling the primary tank to brim full capacity for a minimum of four hours and conducting a visual inspection for leaks. A hydrostatic water test will be conducted if ordered by the customer.

8.7 Workmanship

8.7.1 The finished tank wall shall be free, as commercially practicable, of visual defects such as foreign inclusions, air bubbles, pinholes, pimples, crazing, cracking and delaminations that will impair the serviceability of the vessel. Fine bubbles are acceptable with Type II tanks to the degree in which they do not interfere with proper fusion of the resin melt.

8.7.2 All cut edges where openings are cut into the tanks shall be trimmed smooth.

Table III – Fitting and Accessory Schedule

Tank Number	TNK -	TNK -	TNK -	TNK -
Description	**Quantity / Size**	**Quantity / Size**	**Quantity / Size**	**Quantity / Size**
Inlet nozzle				
Top draw outlet nozzle				
Drain (transition fitting)				
Overflow				
Vent				
Surge Protection Lid				
Fill				
External fill pipe				
Internal fill pipe				
Manway				
Threaded/ vented				
Threaded				
Hinged				
Bolted / Sealed				
Ladder FRP / Galvanized Steel				
Lifting Lugs				
Tie-down Lugs				
Seismic/Wind Tie-down				
Galvanized Steel				
304 SS				
316 SS				
Level Indicator				
Ultrasonic				
Flexible tube				
Mechanical Reverse Float				

Leak Detection System				
Heat System				
Maintenance Temperature				
Min. Ambient Temperature				
Insulation w/mastic coating (gray in color)				

9. Tank Fittings (Nozzles)

9.1 Fittings – Threaded Bulkhead

9.1.1 Threaded bulkhead fittings are available for above liquid installation depending on the tank diameter and the placement of the fitting in the tank. Fittings must be placed away from tank knuckle radius' and flange lines. Consult SII for placement questions. The maximum allowable size for bulkhead fittings placed on a curved cylindrical section of tanks 48 in. to 142 in. in diameter is 2 inch. Tank wall thickness must be considered for bulkhead fitting placement. The maximum wall thickness for each fitting size is shown below.

Fitting Size	Maximum Wall Thickness
1/2 in.	2 in.
3/4 in.	2 in.
1 in.	2 in.
1 1/4 in.	2 in.
1 1/2 in.	2 in.
2 in.	2 in.
3 in.	2.125 in. (Flat Surface Only)

9.1.2 The bulkhead fittings shall be constructed of PVC, PP, or other specified material. Gaskets shall be a minimum of 1/4" thickness and constructed of 40-50 durometer EPDM, 60-70 durometer Viton◆, or other specified material.

9.2 Fittings - Bolted Double 150 lb. Flange Fittings

9.2.1 Bolted double flange fittings are available for below liquid level installation for sizes 2 in. through 4 in. depending on the placement of the fitting in the tank. Fittings must be placed away from tank knuckle radius' and flange lines. Consult SII for placement questions. Bolted double flange fittings provide the best strength and sealing characteristics of any tank fitting available. Allowable fittings sizes based on tank diameter for curved surfaces are shown below.

Tank Diameter	Maximum Bolted Fitting Size Allowable
48 in. - 86 in.	3 in.
90 in. - 102 in.	6 in.
120 in. - 142 in.	8 in.

The bolted double flange fittings shall allow tank wall thickness up to 2 1/2 in.

9.2.2 The bolted double flange fitting shall be constructed with 2 ea. 150 lb. flanges, 2 ea. 150 lb. flange gaskets, and the correct number and size of all-thread bolts for the flange specified by the flange manufacturer. The flanges shall be constructed of PVC Type I, Grade I, or other specified material. Gaskets shall be a minimum of 1/4" thickness and

constructed of 40-50 durometer EPDM, 60-70 durometer Viton◆ or other specified material. There shall be a minimum of 4 ea. full thread bolts. The bolts may have gasketed flanged metal heads or bolt heads encapsulated in Type II polyethylene material. The encapsulated bolt shall be designed to prevent metal exposure to the liquid in the tank and prevent bolt rotation during installation. The polyethylene encapsulation shall fully cover the bolt head and a minimum of 1/4" of the threads closest to the bolt head. The polyethylene shall be color coded to distinguish bolt material (white - 316 S.S., yellow - Hastelloy C276, red - Monel, green - Titanium). Each encapsulated bolt shall have a gasket to provide a sealing surface against the inner flange.

9.2.3 Standard orientation of bolted double flange fittings shall have bolt holes straddling the principal centerline of the tank in accordance with ANSI/ASME B-16.5 unless otherwise specified.

9.3 Fittings - Bolted Stainless Steel Fittings

9.3.1 Bolted stainless steel fittings are available for below liquid level installation depending on the tank diameter and the placement of the fitting in the tank. Fittings must be placed away from tank knuckle radius' and flange lines. Consult SII for placement questions. Allowable fittings sizes based on tank diameter for curved surfaces are shown below.

Tank Diameter	Maximum Bolted Fitting Size Allowable
48 in.	3 in.
64 in. - 142 in.	4 in.

The bolted stainless steel fittings shall allow tank wall thickness up to 2 1/2 in.

9.3.2 The bolted stainless steel fittings shall be constructed with a minimum of 4 fully threaded 3/8 in. studs. Each fitting shall have two gaskets and two flanges. One gasket shall be compressed between the inside of the tank wall surface and the inside flange of the fitting. The other gasket shall be compressed between the outside tank wall surface and the outside flange of the fitting. The stainless steel fittings come standard with female pipe threads on both the inner and outer flanges. Other threading arrangements may be specified. The fittings shall be constructed of Type 316 stainless steel. Gaskets shall be a minimum of ¼" thickness and constructed of 40-50 durometer EPDM, 60-70 durometer Viton◆ or other specified material.

9.4 Fittings – Unified Fitting Outlet (UFO™)

9.4.1 The UFO shall provide a flexible containment seal between the inner primary tank and the outer secondary containment tank. This fitting outlet when used in combination with fittings as per sections 9.2 and 9.3 provides access for connecting piping to the inner primary tank while maintaining containment integrity between the inner primary tank and the outer secondary containment tank. This fitting outlet may be used for 2, 3, and 4 in. fitting sizes.

9.4.2 The fitting outlet shall consist of 1 ea. flexible polyethylene containment boot, 1 ea. appropriate fitting gasket, 1 ea. UFO gasket, 1 ea. solid 304 stainless steel UFO flange, 1 ea. split 304 stainless steel UFO flange, and 12 ea. 3/8 in. 304 stainless steel bolt assemblies. Gaskets shall be a minimum of 1/4" thickness and constructed of 40-50 durometer EPDM, 60-70 durometer Viton◆ or other specified material.

9.5 Fittings - Siphon Tube Fittings

9.5.1 Siphon tubes may be added to the fittings specified in sections 9.2 and 9.3. A siphon tube will allow these fittings, when used as drainage fittings, to provide better tank drainage.

9.6 Vents

9.6.1 Each tank must be properly vented for the type of material and flow rates expected. Vents must comply with OSHA 1910.106 (f) (2) (iii) or other accepted standard. All tanks

must be vented for atmospheric pressure as well as any pressure created by filling and emptying the tank. Some applications may require a sealed tank with a vent line going to a scrubber system for proper chemical safety. Venting equipment should be sized to limit pressure or vacuum in the tank to a maximum of 1/2" of water column (0.02 psi). U-Vents are offered in sizes from 1 in. to 6 in. with or without mesh insect screening. U-Vents with mesh screening may require additional sizing due to reduced air-flow rates. Consult the manufacturer for necessary venting and placement information.

9.6.2 All u-vents shall be constructed of PVC or other specified materials.

9.6.3. When a tank is being filled from a pressurized tanker truck or rail car steps need to be taken to avoid pressurizing the tank. The tank may require a secondary surge protection lid to avoid any pressure build up. The surge protection lid is to be a 14” or 18” hinged and be design that it is self-closing.

9.7 Flange Adapters

9.7.1 Flange adapters may be purchased as optional equipment to adapt threaded or socket fitting outlets to 150 lb. flange connections for connection to piping system components. Flange adapters are available in PVC, CPVC or other specified materials. Flange adapter construction shall utilize schedule 80 components in sizes ranging from ¾” to 8” depending on material required.

9.8 Fittings - Self-Aligning Threaded Bulkhead

9.8.1 Self-Aligning fittings are available for installation in vapor phase applications on curved surfaces depending on the spherical dome radius and the placement of the fitting on the tank dome. Fittings must be placed away from tank radius’. Consult SII for placement questions. The maximum allowable size for self-aligning fittings placed on a spherical section of the tank is shown below.

Tank Diameter	Maximum Fitting Size Allowable
45 in. – 48 in.	2 in.
64 in. – 142 in.	3 in.

Tank thickness and fitting angle may need to be considered for self-aligning fitting placement. The maximum thickness and installation angles for each fitting size are shown below.

Fitting Size	Maximum Angle	Maximum Thickness
1 in.	27 degrees	1.000 in.
2 in.	25 degrees	0.750 in.
3 in.	20 degrees	1.000 in.

9.8.2 The self-aligning fittings shall be constructed of PVC or CPVC. Gaskets shall be a minimum of 1/4" thickness and constructed of 40-50 durometer EPDM, 60-70 durometer Viton◆, or other specified material.

9.9 Flexible Connections

9.9.1 All tank fitting attachments shall be equipped with flexible couplers or other movement provisions provided by the tank customer. The tank will deflect based upon tank loading, chemical temperature and storage time duration. Tank piping flexible couplers shall be designed to allow 4% design movement. Movement shall be considered to occur both outward in tank radius and downward in fitting elevation from the neutral tank fitting placement.

9.1.2 The flexible connection is to be manufactured of the same material as the tank or a compatible material approved by the project engineer. If an elastomer flexible connection is used control bolts are required if recommended by the manufacturer. The flexible

connection is to be designed for a minimum of 4% movement. The flexible connection is to be designed with 150# flange connections to allow for attachment to the tank and the piping system. The flexible connection is to be attached as close as possible to the tank to reduce stress.

10. Tank Attachments

10.1 Tank Attachments – Ultrasonic Level Indicator

10.1.1a. The ultrasonic enclosure is to be an all plastic design with a NEMA 4X rating. The ultrasonic transducer is to have a 12" dead band and beam with a 20 ft range. The supply voltage can be 110, 220 VAC or 24 VDC. The connection to the tank is to be 2" NPT.

The ultrasonic level indicator shall provide a visual display of liquid level in the tank showing gallonage in measurement of hundreds of gallons along with 4-20 mA output for other alarm or control systems as well as four independent contacts capable of handling 10 amps each. Each contact can be programmed to operate in different opening and closing methods (7 modes). Contacts can be used to control pumps, valves, alarms, etc.

10.2 Tank Attachments – Leak Detector Unit

10.2.1 The leak detector unit shall consist of a proximity sensor, a welded 2 in. fpt connection, a 2 in. bung plug with a ¾ in strain relief, and an indicator box. The sensor is placed in the interstitial space between the primary and secondary tanks approximately 1 in. above the tank bottom. The indicator box shall be Nema 4 rated and factory pre-wired for 110 VAC power. All connections shall be labeled to prevent errors in field installation. The indicator box will show a green light when power is on and the sensor is not detecting a liquid. The light is a push to test light allowing the operator to test for power outage or malfunction. If the green light goes out there are two possibilities. The green light does not come on when the button is pushed. This would indicate a lack of power to the unit or the light bulb is burned out. If the green light comes on when pushed, then a possible leak condition is indicated.

10.3 Level Indication

10.3.1 Sight Level Gage

a. The sight level gage shall be constructed of flexible PE or PVC tubing to allow for tank contraction and expansion due to loading and temperature changes. The level gage shall be connected to the tank at the top of the tank with 1ea. appropriate 3/4" fitting as described in section 9.1 or 9.2. and to a tee off of the drain / transition fitting. Each fitting can have valves installed for isolation or drainage purposes.

10.3.2 Manway and Fill Cap (Non-sealed)

10.3.1 Fill caps are available in a 10 in. vented-threaded style on various tank sizes with a minimum opening diameter of 7.125 in. Cap attachment shall be provided with all standard 10 in. cap placements with a polyurethane cap tie. Check the manufacturer's specification drawing for availability and position.

10.3.2 Manways are available in an 18 in. vented or non-vented threaded design or hinged style (minimum opening diameter of 15 in.) and a 24 in. vented or non-vented threaded or hinged style (minimum opening diameter of 22 in.) on various tank sizes. Check the manufacture's specification drawing for availability and position.

10.3.3 All caps and manways shall be constructed of polyethylene material.

10.4 Bolted Sealed Top Manway

10.4.1 Sealed manways are available in 14, 18, 20 and 24 in. sizes on certain tanks in selected positions. Consult the manufacturer for placement positions.

10.4.2 The sealed manway shall be constructed of polyethylene material. The bolts shall be polypropylene or other specified material. The gaskets shall be closed cell, crosslinked polyethylene foam and Viton◆ o-rings to seal the bolts.

10.5 Surge Protection Lid

10.5.1 The hinged lid is to be manufactured of polyethylene. The lid will be a 14 in. size with 11 in. access opening or 18" with 15" access. The opening of the lid is to be restricted by a tether. The lid is to be designed so that is will close when the pressure has been released. Check SII specification drawing for availability and position.

10.6 Tank Attachments – External Fill Pipes

10.6.1 External fill pipes shall be prepared per the customer approved drawings and specifications. All external fill pipes shall be supported at 3 ft. maximum intervals with a support structure independent of the tank (ground supported). All designs shall be done according to the specific needs of the customer.

10.6.2 All external fill pipes shall be constructed of PVC or other specified materials.

10.7 Tank Attachments – Internal Down Pipes

10.7.1 Internal down pipes shall be prepared per the customer approved drawings and specifications. All internal down pipes shall be supported at 5 ft. maximum intervals with a support structure welded to the inside of the primary tank (only available in tanks constructed with Type II resin). The support design may utilize a PVC clamp or other specified materials for support. All designs shall be done according to the specific needs of the customer.

10.7.2. All internal down pipes shall be constructed of PVC or other specified materials.

11. Tank Accessories

11. Ladders

11.1 Ladders shall be constructed of galvanized mild steel or FRP.

11.2 Safety cages shall be provided with ladders as optional equipment unless required by OSHA standards.

11.3 All ladders shall be designed to meet applicable OSHA standards. Reference: OSHA 2206; 1910.27; fixed ladders.

11.4 Ladders must be mounted to the tank to allow for tank expansion and contraction due to temperature and loading changes. All top ladder mounts shall be connected to integrally molded in attachment lugs that allow for tank movement due to temperature and loading changes.

11.5 Mild steel parts shall be deburred and galvanized.

12.0 Tie Down Systems

12.1 The tie down system shall be designed to withstand 150 MPH wind loads. Tie down systems must meet seismic requirements per IBC 2009 / CBC 2010 code with seismic loads ≤ .445g (Seismic Design Category "D" - Fa=1.0, Fv=1.5, Ss=1.4, S1=0.5). Anchor bolts shall be provided by the contractor per the calculations and the base plates for the system. A registered engineer's wet stamped calculations and or drawings may be required.

12.2 The tie down system shall be offered galvanized, 304 or 316 stainless steel.

12.3 Mild steel parts shall be deburred and galvanized.

13.0 Tank Accessories - Tank Heating Systems

13.1 Heating systems for use with polyethylene tanks shall be designed to meet specific requirements such as tank material type, tank size, low ambient temperature, and desired maintenance temperature.

13.2 All control components of the heating system shall be mounted in water tight, high impact plastic box(es) with a gasketed cover.

13.3 All heating system components shall be Nema 4 rated and factory pre-wired for 110 VAC. All connections shall be labeled to prevent errors in field installation.

13.4 Each control box shall carry a decal attached to the inside surface of the cover, on which an electrical wiring diagram will be printed.

13.5 Each control box shall contain two temperature controls. One control shall regulate the maintenance temperature setting and the other control shall regulate the high temperature setting. The maintenance temperature setting should be set at the desired maintenance temperature. The high temperature setting shall be adjusted to 10 degrees above the desired maintenance temperature to a maximum of 130 degrees Fahrenheit. All control systems must be designed with a power off failure mode.

13.6 The heating panels shall be designed to wrap around and lie flat against the surface of the secondary containment tank. The heating panels shall have a maximum heating density of 0.022 watts per square centimeter. All heating panels and sensor bulbs shall be attached to the tank with 2" wide duct tape. The high temperature sensor shall directly sense the temperature of the heating panels on the secondary containment tank. The maintenance temperature sensor shall directly sense the temperature of the inner primary tank. Under no circumstances shall cable type heaters be used with polyethylene tanks.

13.7 Insulation used shall be polyurethane foam with a density of 2.0 - 3.0 lb./ft ^3 with a "R" value of 8.33/in. The foam shall be applied with a nominal thickness of 2" to all external tank surfaces except the tank bottom shell.

13.8 Upon completion of application and curing of the insulation, two full coverage coats of latex mastic coating shall be applied to the surface of the insulation in such manner as to seal the insulation from the outside environment.

14. Warranty

14.1 The tank shall be warranted for three years in regards to defects in materials and workmanship. The warranty on fittings and accessories that are supplied by the tank manufacturer will be for one year. The warranty will begin at time of shipment.

15. Marking, Packing and Packaging

15.1 The tanks shall be marked to identify the product, date (month and year) of manufacture, capacity, and serial number. The tank shall be shipped with a 3 of 9, HRI bar code label containing tank description, manufacturing order number, part number, serial number, manufacturer, and date.

15.2 The proper caution or warning signs as prescribed by OSHA standard 29 CFR 1910.106 shall be customer determined and supplied.

15.3 All packing, packaging, and marking provisions of ASTM Practice D3892 shall apply to this standard.

15.4 Customer specified labeling is available.

15.5 Tank shrink wrapping and bagging is available upon customer request.

15.6 All fittings that do not interfere with tank shipment shall be installed unless otherwise specified. Fittings and accessories that interfere with tank shipment or could be broken during shipment are shipped separately.

16. Shipping

16.1 Since there are variations in methods of shipping, SII's instructions shall be followed in all cases.

16.2 Consult the SII “Guidelines for Use and Installation” booklet included with your tank for unloading instructions on specific tanks. This booklet can be found attached to the cap or manway area on the inside of the tank. Tanks with capacities of 2000 gallons or more have molded-in lifting lugs provided to assist with tank handling. All tank units are shipped with shipping cables allowing the two tanks to be handled as a unit during shipping and tank handling. Once the tank is put into position the shipping cables are to be removed to allow the tank to fully contact the tank pad/support area.

16.3 Upon arrival at the destination, the purchaser and/or his agent shall be responsible for inspection for damage in transit. If damage has occurred, a claim should be filed with the carrier by the purchaser, and the manufacturer should be notified prior to the tank being put into service.

17. Delivery & Storage

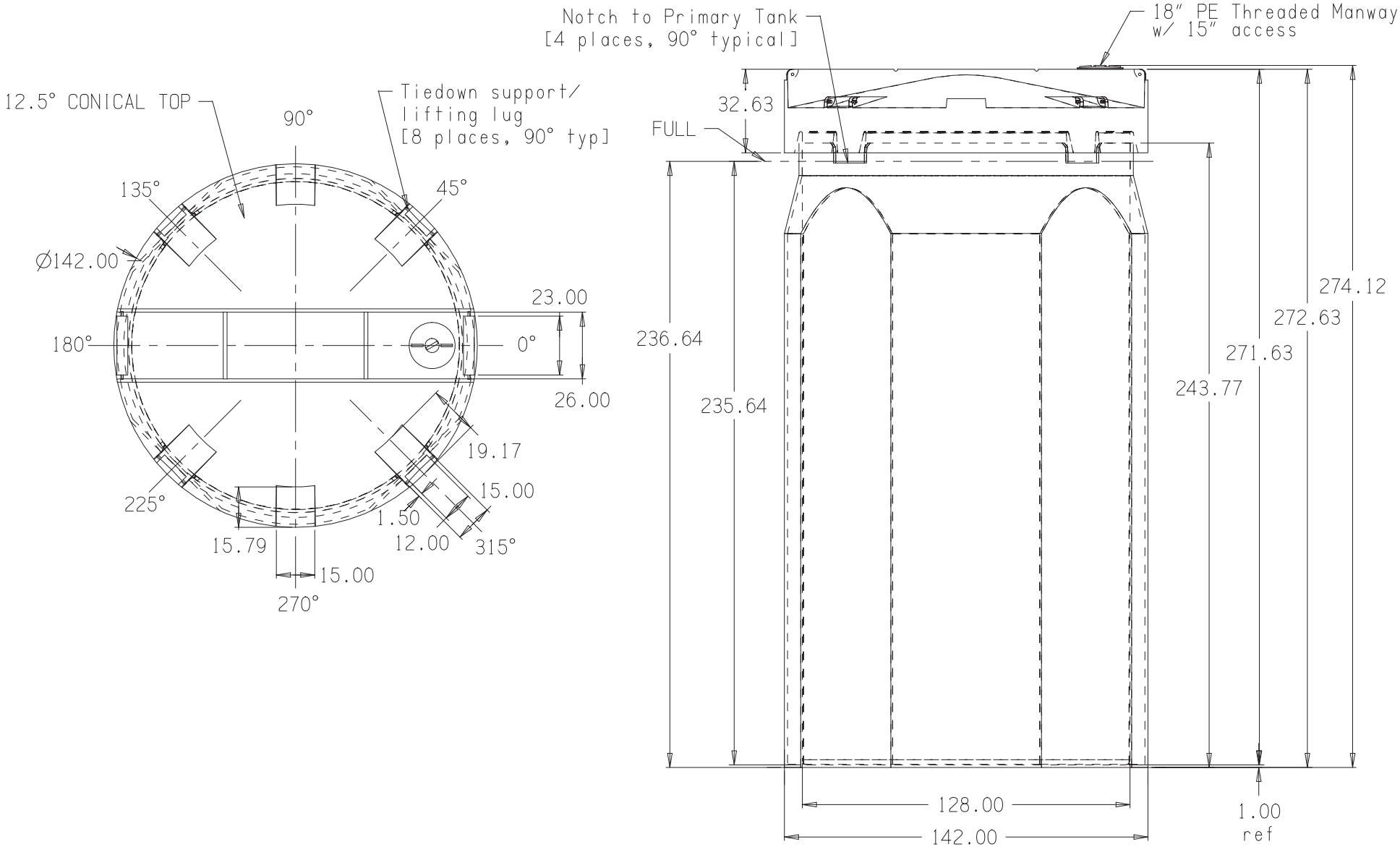
17.1 Installation

17.1.1 Transportation, handling, storage of the tanks, and installation shall be in accordance with the manufacturer's printed instructions.

17.1.2. Repair any damage to tank components or the insulation due to transportation or installation.

17.1.3. All tank fitting attachments shall be equipped with flexible couplers or other movement provisions provided by the tank customer. The tank will deflect based upon tank loading, chemical temperature and storage time duration. Tank piping flexible couplers shall be designed to allow 4 percent design movement. Movement shall be considered to occur both outward in tank radius and downward in fitting elevation from the neutral tank fitting placement.

17.1.4. The installer is to certify in writing that the tank system has been installed according to the tank manufacturer’s Guidelines for Use & Installation.

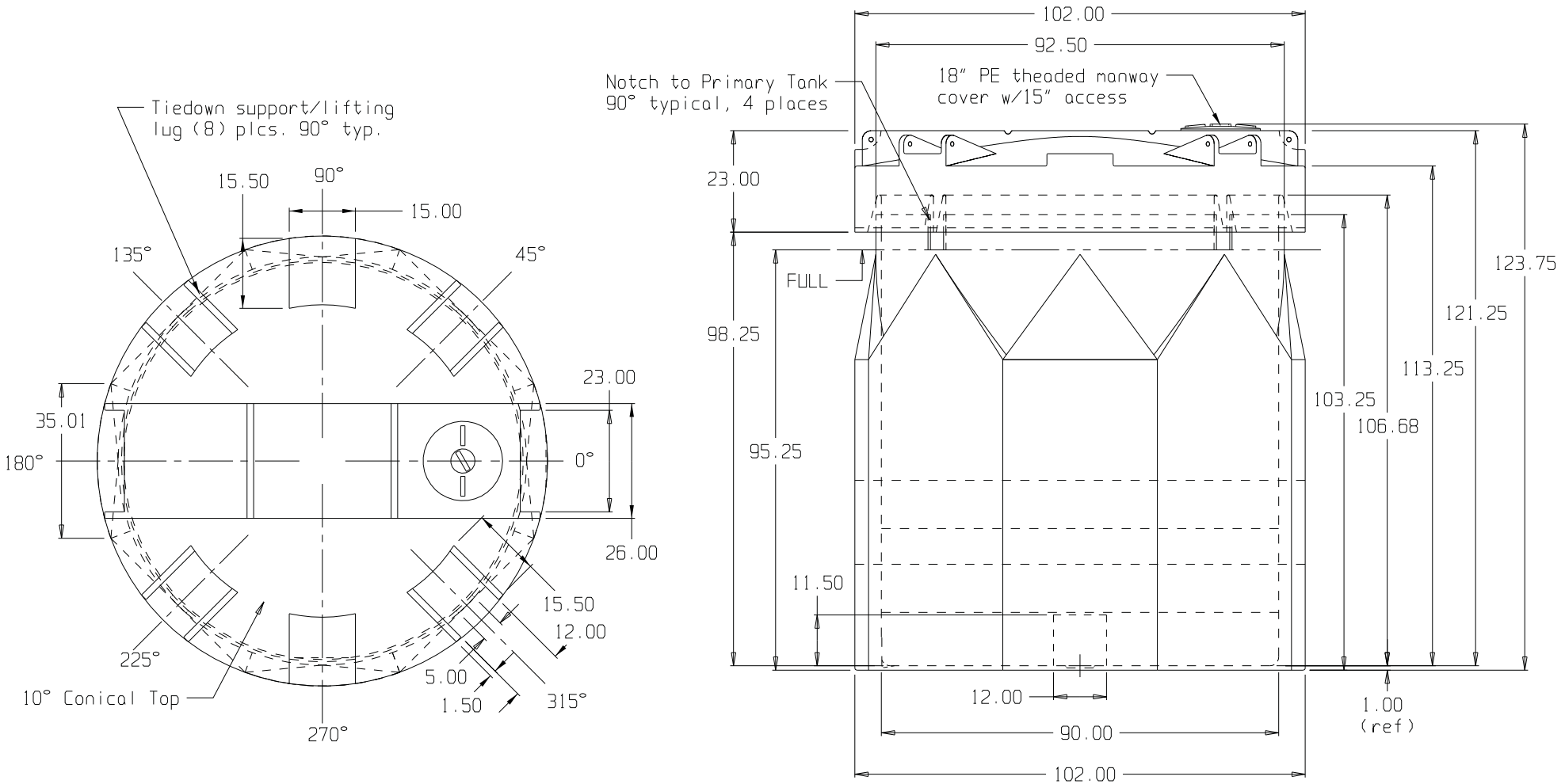


SNYDER INDUSTRIES INC.

* BASE FITTINGS TO BE LEFT INSTALLED AT TIME OF SHIPMENT PER SII PROCEDURE
* Consult Snyder's Guidelines for Use and Installation prior to delivery. Available on-line at www.snydernet.com (all dimensions in inches)

12,500 GALLON CAPTOR CONTAINMENT SYSTEM

PART #	PRIMARY:	1031100N
	CONTAINMENT:	1031200N
REF#:	00000	02/04/13



SNYDER INDUSTRIES INC.

(all dimensions in inches)

BASE FITTINGS TO BE LEFT INSTALLED AT TIME OF SHIPMENT PER Sii PROCEDURE

2,500 GALLON CAPTOR CONTAINMENT SYSTEM

PART #	PRIMARY:	5580--
	CONTAINMENT:	5510--
REF#:	0000	07/29/02

Japanese >

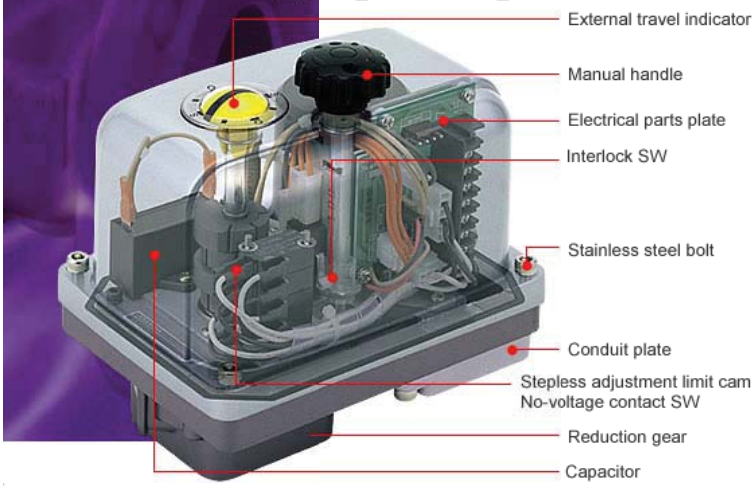
Selecting a Valve by Operating Mode > Electic Actuators EX Series > EXH

Selecting a Valve by Operating Mode

EX series
EXH
EXS
EXCN

EXH EX SERIES

High-speed Actuators for Ball Valves Ensuring stable, high-speed valve operation at all times.



The EXH Series are high-speed, electric actuators for ball valves.

♦Cyclo speed reducer employed
♦The stepless adjustment limit cam and no-voltage contact SW are included as standard specifications.
♦With interlock switch

Standard Specifications

Actuator size		Type 1		Type 2		Type 3		Type 4	
Model		EXH100-1	EXH200-1	EXH100-2	EXH200-2	EXH100-3	EXH200-3	EXH100-4	EXH200-4
Power supply (single-phase, 50/60 Hz, AC)		100V±10%	200V±10%	100V±10%	200V±10%	100V±10%	200V±10%	100V±10%	200V±10%
Rated current∗1 (A)		0.65	0.35	0.65	0.35	1.2	0.6	2.8	1.5
Quarter-turn (90°) opening / closing time∗2	50Hz (sec)	About 9		About 14		About 21		About 28	
	60Hz (sec)	About 8		About 12		About 17		About 23	
Rated output torque (N¥m)		9.8		49		196		588	
Motor output (W)		16				31		85	
Motor power consumption (W)		65				120		280	270
Motor protection		Built-in thermal protector (120°C open)							
Rotating direction		Open: counterclockwise, viewed from the top of the actuator Closed: clockwise, viewed from the top of the actuator							
Duty factor		30% ED or lower (at a room temperature of 20°C)							
Position detecting limit SW∗3		2 Switches, each for open / closing positions (no-voltage contact SWs for stop and signals at fully-open and fully-closed ends). Contact capacity: 250 VAC, 11 A (Resistance load)							
Operating environment		Indoors and outdoors (Not submersible in water)							
Waterproofing / Explosion-proofing		Compliant with IP67							
Space heater capacity (W)		10/15 (at 100V/200V)						20	
Space heater consumption power (W)		2.5/2.9 (at 100/200V)						4	
Ambient temperature (°C)		−10 ~ 50							
Insulation class		JIS C 4003 Class E							
Insulation withstand voltage		1 min. at 1500 VAC or 1 sec at 1800 VAC							
Insulation resistance		100 MΩ or higher when measured with a 500-VDC insulation tester							
Mounting attitude		Upright or horizontal (cannot be mounted upside down)							
Lubricant		Grease							
Conduit connection		G1 / 2 x 1 end connection							
Wire connection		Screw terminal block M3							
Stopper		Open / closed end fixed mechanical stopper							
Manual operation		Pull up and turn the round handle on the top of the cover. The built-in interlock switch cuts off the power supply to the motor and space heater during manual operation.							
Power return		Push the handle down							

Connection flange	Conforming to ISO5211		
Coating colors	Cover: metallic silver. Case: metallic dark gray. Handle: matte black.		
Weight∗4 (kg)	About 4.4	About 7.3	About 12.3

∗1 At startup, a current as high as approximately ten times the rated current surges through the actuator. Allow a sufficient safety margin for any electrical device connected to the actuator.
∗2 The quarter-turn (90°) opening / closing time indicated above refers to a time when the actuator is not connected to any valve and is not under any load. There will be a 3 to 10% delay when the actuator is connected to a valve.
∗3 Specify auxiliary limit switches (gold contacts) if your equipment employs a microcurrent load of 50 mA or less.
∗4 Weight of the actuator when not connected to a valve.

SAFETY WITHOUT COMPROMISE

THERMOPLASTIC RESIN VENTS

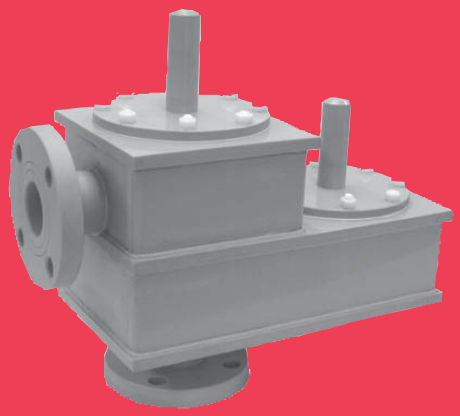
Highly Resistant to Acids & Chemically Hostile Environments

PROTECTOSEAL

SERIES*	STYLE	SIZES
__6240B	End-of-Line Vacuum	2" - 8"
__7800B	End-of-Line Pressure	2" - 8"
__8540B	End-of-Line Pressure & Vacuum	2" - 8"
__16240B	Side Mounted Vacuum	2" - 8"
__17800B	Pipe-Away Pressure or Vacuum	2" - 8"
__18540B	Pipe-Away Pressure & Vacuum	2" - 8"

** PREFIX DESIGNATIONS*

"PVC" - Polyvinyl Chloride *"PVDF" - Polyvinylidene Fluoride*
"PP" - Polypropylene *"PE" - Polyethylene*



POLY VENTS

OBJECTIVE

Protectoseal's Thermoplastic Resin Vents are designed to provide pressure and/or vacuum relief to control hazardous vapors that would attack metallic vents or components. Through the use of these plastic materials, a wide range of tank storage, product conservation, and environmental regulation applications can be served. These include chemical processing, petrochemical, petroleum, pharmaceutical, pulp & paper, semiconductor, ultrapure water, wastewater and food / beverage. These vents may be effective in severe applications such as hydrochloric, hydrofluoric and sulfuric acids at high process temperatures. The versatility of these materials allows for their use instead of exotic metals.

TECHNIQUE

Normal conservation breather bents feature pressure and vacuum pallets in the vent housing that retard intake of air and escape of vapors under normal conditions. Pallets open and close to permit only the intake or outlet relief necessary to remain within permissible working limits and avoid damage to tanks, low pressure vessels and piping. In pipe-away models, relieved vapors are piped away through a flanged connection.

SPECIAL FEATURES

Fast Inspection, Easy Maintenance. Highest quality rugged design and light weight provides for a long service life, ease of installation, inspection and preventative maintenance.

Maintains Accurate Pressure Settings. Factory tested and certified prior to shipment. Every unit meets Protectoseal's stringent requirements for accuracy. Leakage on vent pallets at standard settings is 1 SCFH or less at 90% of the set pressure.

Automatic Condensate Drainage. Self-draining body design keeps condensate away from seating surface.

Air-Cushioned Seating. Protectoseal's patented and exclusive air-cushioned seating for low evaporation losses. FEP film diaphragms are standard, other materials can be furnished on special request. The pallets have peripheral guiding and center stabilizing stem to ensure proper alignment and tight seating.

Numerous Sizes Available. All vents in the sizes shown above mate with standard flanged 125# ANSI or DIN PN 16 bolting specifications. Other drilling patterns are also available upon special request.

PRO-FLOW III® Sizing and Selection Software. Use PRO-FLOW III® to select the correct size unit for pressure and vacuum relief calculated in accordance with API 2000, ISO 28300, NFPA 30 and OSHA 1910.106.

CONSTRUCTION

Protectoseal vents manufactured from Polyvinyl Chloride (PVC), Polypropylene (PP), Polyvinylidene Fluoride (PVDF) and Polyethylene (PE) are highly resistant to acids and chemically hostile environments, yet extremely rugged and durable in construction. The vents are constructed using no metal parts including exterior hardware. This will ensure a long service life in corrosive atmospheres.

"PVC" Prefix - Polyvinyl Chloride (PVC) body, cover and hood; PVC pallet assembly components; FEP diaphragms; PVC hardware; 316 S.S. or lead weights, if required.

"PVDF" Prefix - Polyvinylidene Fluoride (PVDF) body, cover and hood; PVDF pallet assembly components; FEP diaphragms; PVDF hardware; 316 S.S. or lead weights, if required.

"PP" Prefix - Polypropylene (PP) body, cover and hood; Polypropylene pallet assembly components; FEP diaphragms; Polypropylene hardware; 316 S.S. or lead weights, if required.

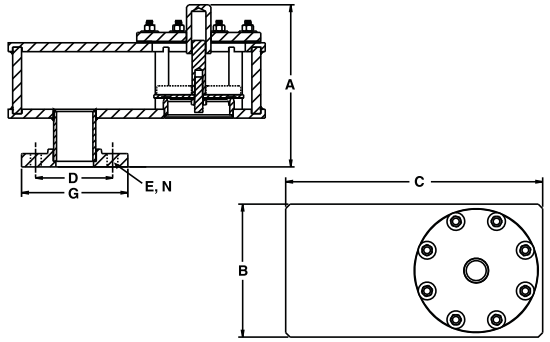
"PE" Prefix - Polyethylene (PE) body, cover and hood; Polyethylene pallet assembly components; FEP diaphragms; Polyethylene hardware; 316 S.S. or lead weights, if required.

Available Options.

- Alternate diaphragm materials
- Derakane® 470, Derakane® 411 or Furan coated weights

Specifications

Series No. ___6240B - End-of-Line Vacuum Relief Vent *(Dimensions shown are for reference only, contact factory for certified drawings.)*



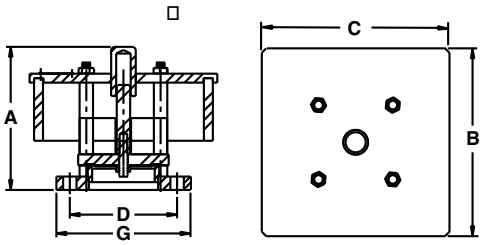
Cat. No.*	Flange Size	Ht. A	Width B	Length C	B.C. D	Dia. G	Dia. E	Holes N
___6242B	2"	9 1/8"	7 1/2"	14 1/2"	4 3/4"	6"	3/4"	4
___6243B	3"	9 3/8"	7 1/2"	14 1/2"	6"	7 1/2"	3/4"	4
___6244B	4"	9 5/8"	9 1/4"	18 3/4"	7 1/2"	7 1/2"	3/4"	8
___6246B	6"	13 1/2"	11 1/2"	23"	9 1/2"	11"	7/8"	8
___6248B	8"	14"	14 1/2"	27 1/2"	11 3/4"	13 1/2"	7/8"	8

** Prefix Designations: "PVC" - Polyvinyl Chloride; "PVDF" - Polyvinylidene Fluoride; "PP"- Polypropylene; "PE" - Polyethylene*

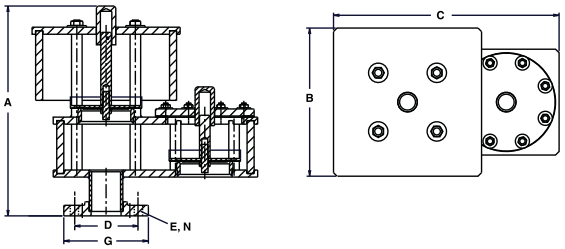
Series No. ___7800B - End-of-Line Pressure Relief Vent *(Dimensions shown are for reference only, contact factory for certified drawings.)*

Cat. No.*	Flange Size	Ht. A	Width B	Length C	B.C. D	Dia. G	Dia. E	Holes N
___7802B	2"	8 1/4"	10 1/2"	10 1/2"	4 3/4"	6"	3/4"	4
___7803B	3"	8"	10 1/2"	10 1/2"	6"	7 1/2"	3/4"	4
___7804B	4"	9"	12 7/8"	12 7/8"	7 1/2"	9"	3/4"	8
___7806B	6"	10 7/8"	15 1/8"	15 1/8"	9 1/2"	11"	7/8"	8
___7808B	8"	12"	18 1/2"	18 1/2"	11 3/4"	13 1/2"	7/8"	8

** Prefix Designations: "PVC" - Polyvinyl Chloride; "PVDF" - Polyvinylidene Fluoride; "PP"- Polypropylene; "PE" - Polyethylene*



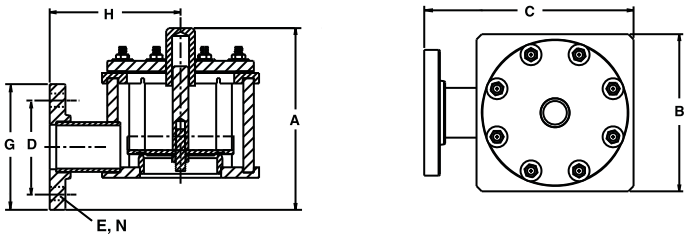
Series No. ___8540B - End-of-Line Pressure & Vacuum Breather Vent *(Dimensions shown are for reference only, contact factory for certified drawings.)*



Cat. No.*	Flange Size	Ht. A	Width B	Length C	B.C. D	Dia. G	Dia. E	Holes N
___8542B	2"	14 7/8"	10 1/2"	16"	4 3/4"	6"	3/4"	4
___8543B	3"	15"	10 1/2"	16"	6"	7 1/2"	3/4"	4
___8544B	4"	16"	12 7/8"	20 1/2"	7 1/2"	9"	3/4"	8
___8546B	6"	19 1/8"	15 1/8"	24 7/8"	9 1/2"	11"	7/8"	8
___8548B	8"	20 3/4"	18 1/2"	30 1/4"	11 3/4"	13 1/2"	7/8"	8

** Prefix Designations: "PVC" - Polyvinyl Chloride; "PVDF" - Polyvinylidene Fluoride; "PP"- Polypropylene; "PE" - Polyethylene*

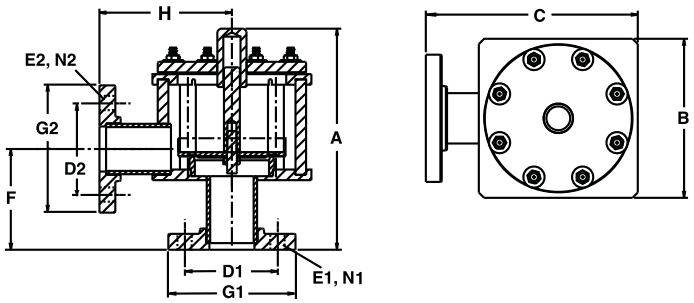
Series No. ___16240B - Side Mounted Vacuum Relief Vent *(Dimensions shown are for reference only, contact factory for certified drawings.)*



Cat. No.*	Flange Size	Valve Size	Ht. A	Width B	Length C	Width H	B.C. D	Dia. G	Dia. E	Holes N
___16240B2	2"	2"	8 3/4"	7 1/2"	10"	6 1/4"	4 3/4"	6"	3/4"	4
___16240B3	3"	3"	8 1/8"	7 1/2"	10 1/4"	6 1/2"	6"	7 1/2"	3/4"	4
___16240B4	4"	4"	12"	9 1/4"	12 1/4"	7 1/2"	7 1/2"	9"	3/4"	8
___16240B6	6"	6"	13"	11 1/2"	14 1/4"	8 1/2"	9 1/2"	11"	7/8"	8
___16246B8	8"	6"	16 5/8"	11 1/2"	14 1/4"	8 1/2"	11 3/4"	13 1/2"	7/8"	8

** Prefix Designations: "PVC" - Polyvinyl Chloride; "PVDF" - Polyvinylidene Fluoride; "PP"- Polypropylene; "PE" - Polyethylene*

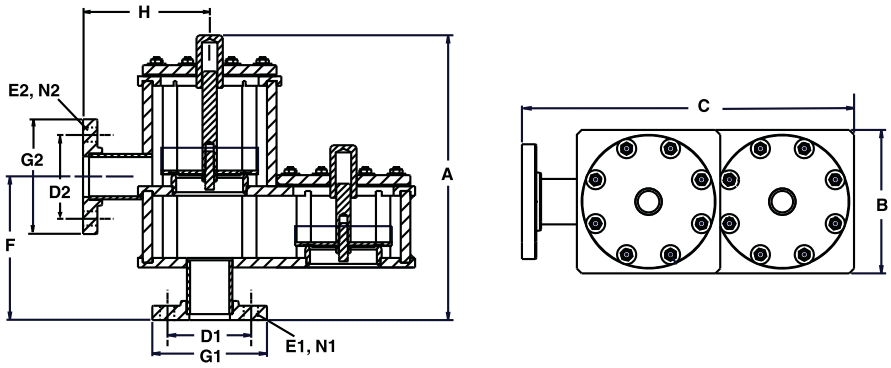
Series No. ___17800B - Pipe-Away Pressure or Vacuum Breather Vent *(Dimensions shown are for reference only, contact factory for certified drawings.)*



Cat. No.*	Flange Size Inlet x Outlet	Ht. A	Width B	Length C	F	H	B.C. D1	B.C. D2	Dia. G1	Dia. G2	Dia. E1	Dia. E2	Holes N1	Holes N2
___17802B2	2" x 2"	10 1/2"	7 1/2"	10"	4 3/4"	6 1/4"	4 3/4"	4 3/4"	6"	6"	3/4"	3/4"	4	4
___17802B3	2" x 3"	11 1/2"	7 1/2"	10"	5 1/4"	6 1/2"	4 3/4"	6"	6"	7 1/2"	3/4"	3/4"	4	4
___17803B3	3" x 3"	11 5/8"	7 1/2"	10 1/4"	5 1/2"	6 1/2"	6"	6"	7 1/2"	7 1/2"	3/4"	3/4"	4	4
___17803B4	3" x 4"	11 5/8"	9"	10 1/4"	6"	6 1/2"	6"	7 1/2"	7 1/2"	9"	3/4"	3/4"	4	8
___17804B4	4" x 4"	13 1/2"	9 1/4"	11 7/8"	6"	7 1/4"	7 1/2"	7 1/2"	9"	9"	3/4"	3/4"	8	8
___17804B6	4" x 6"	13 1/2"	11"	12"	7"	7 3/8"	7 1/2"	9 1/2"	9"	11"	3/4"	7/8"	8	8
___17806B6	6" x 6"	16 7/8"	11 1/2"	14 1/4"	7"	8 1/2"	9 1/2"	9 1/2"	11"	11"	7/8"	7/8"	8	8
___17806B8	6" x 8"	16 7/8"	11 1/2"	14 1/4"	7"	8 1/2"	9 1/2"	11 3/4"	11"	13 1/2"	7/8"	7/8"	8	8
___17808B10	8" x 10"	20 5/8"	13"	16 1/4"	10 1/2	9 3/4"	11 3/4"	14 1/4"	13 1/2"	16"	7/8"	1"	8	12

** Prefix Designations: "PVC" - Polyvinyl Chloride; "PVDF" - Polyvinylidene Fluoride; "PP"- Polypropylene; "PE" - Polyethylene*

Series No. ___18540B - Pipe-Away Pressure & Vacuum Breather Vent *(Dimensions shown are for reference only, contact factory for certified drawings.)*



Cat. No.*	Flange Size Inlet x Outlet	Ht A	Width B	Length C	F	H	B.C. D1	B.C. D2	Dia. G1	Dia. G2	Dia. E1	Dia. E2	Holes N1	Holes N2
___18542B2	2" x 2"	14 7/8"	7 1/2"	17 1/2"	7 1/2"	6 5/8"	4 3/4"	4 3/4"	6"	6"	3/4"	3/4"	4	4
___18542B3	2" x 3"	14 7/8"	7 1/2"	17 1/2"	8"	6 7/8"	4 3/4"	6"	6"	7 1/2"	3/4"	3/4"	4	4
___18543B3	3" x 3"	15 1/8"	7 1/2"	17 1/2"	8 1/4"	6 7/8"	6"	6"	7 1/2"	7 1/2"	3/4"	3/4"	4	4
___18543B4	3" x 4"	15 1/8"	9"	17 1/2"	8 3/4"	6 7/8"	6"	7 1/2"	7 1/2"	9"	3/4"	3/4"	4	8
___18544B4	4" x 4"	17 1/8"	9 1/4"	21 3/4"	9 1/8"	7 5/8"	7 1/2"	7 1/2"	9"	9"	3/4"	3/4"	8	8
___18544B6	4" x 6"	16 7/8"	11"	21 3/4"	10 1/4"	7 3/8"	7 1/2"	7 1/2"	9"	9"	3/4"	3/4"	8	8
___18546B6	6" x 6"	22 5/8"	11½"	26"	12 1/2"	8 1/2"	9 1/2"	9 1/2"	11"	11"	7/8"	7/8"	8	8
___18546B8	6" x 8"	22 5/8"	11½"	26"	13 1/2"	8 1/2"	9 1/2"	11 3/4"	11"	13½"	7/8"	7/8"	8	8
___18548B10	8" x 10"	25 3/8"	14¼"	30¾"	15 1/8"	9 3/4"	11 3/4"	14 1/4"	13½"	16"	7/8"	1"	8	12

** Prefix Designations: "PVC" - Polyvinyl Chloride; "PVDF" - Polyvinylidene Fluoride; "PP"- Polypropylene; "PE" - Polyethylene*

STANDARD PRESSURE AND/OR VACUUM SETTINGS *(Consult factory for settings outside of STANDARD range.)*

		MINIMUM SETTINGS				MAXIMUM SETTINGS	
		PVC / PP / PE		PVDF Only		All Materials	
	Flange	Pressure	Vacuum	Pressure	Vacuum	Pressure	Vacuum
Cat. No.*	Size	oz./in.²	oz./in.²	oz./in.²	oz./in.²	oz./in.²	oz./in.²
* Prefix Designations: "PVC" - Polyvinyl Chloride; "PVDF" - Polyvinylidene Fluoride; "PP"- Polypropylene; "PE" - Polyethylene							
END-OF-LINE VACUUM RELIEF VENT							
___ 6242B	2"	N/A	0.50	N/A	0.75	N/A	4.00
___ 6243B	3"	N/A	0.50	N/A	0.75	N/A	4.00
___ 6244B	4"	N/A	0.50	N/A	0.50	N/A	4.00
___ 6246B	6"	N/A	0.50	N/A	0.50	N/A	4.00
___ 6248B	8"	N/A	0.50	N/A	0.50	N/A	4.00
END-OF-LINE PRESSURE RELIEF VENT							
___ 7802B	2"	1.00	N/A	1.00	N/A	16.00	N/A
___ 7803B	3"	1.00	N/A	1.00	N/A	16.00	N/A
___ 7804B	4"	1.00	N/A	1.00	N/A	16.00	N/A
___ 7806B	6"	1.00	N/A	1.00	N/A	16.00	N/A
___ 7808B	8"	1.00	N/A	1.00	N/A	16.00	N/A
END-OF-LINE PRESSURE & VACUUM BREATHER VENT							
___ 8542B	2"	0.50	0.50	0.75	0.75	16.00	4.00
___ 8543B	3"	0.50	0.50	0.75	0.75	16.00	4.00
___ 8544B	4"	0.50	0.50	0.50	0.50	16.00	4.00
___ 8546B	6"	0.50	0.50	0.50	0.50	16.00	4.00
___ 8548B	8"	0.50	0.50	0.50	0.50	16.00	4.00
SIDE MOUNTED VACUUM RELIEF VENT							
___ 16240B2	2"	N/A	0.50	N/A	0.75	N/A	16.00
___ 16240B3	3"	N/A	0.50	N/A	0.75	N/A	16.00
___ 16240B4	4"	N/A	0.50	N/A	0.50	N/A	16.00
___ 16240B6	6"	N/A	0.50	N/A	0.50	N/A	16.00
___ 16246B8	8"	N/A	0.50	N/A	0.50	N/A	16.00
PIPE-AWAY PRESSURE OR VACUUM RELIEF VENT							
___ 17802B2	2" x 2"	0.50	0.50	0.75	0.75	16.00	16.00
___ 17802B3	2" x 3"	0.50	0.50	0.75	0.75	16.00	16.00
___ 17803B3	3" x 3"	0.50	0.50	0.75	0.75	16.00	16.00
___ 17803B4	3" x 4"	0.50	0.50	0.75	0.75	16.00	16.00
___ 17804B4	4" x 4"	0.50	0.50	0.50	0.50	16.00	16.00
___ 17804B6	4" x 6"	0.50	0.50	0.50	0.50	16.00	16.00
___ 17806B6	6" x 6"	0.50	0.50	0.50	0.50	16.00	16.00
___ 17806B8	6" x 8"	0.50	0.50	0.50	0.50	16.00	16.00
___ 17808B10	8" x 10"	0.50	0.50	0.50	0.50	16.00	16.00
END-OF-LINE PRESSURE / VACUUM BREATHER VENT							
___ 18542B2	2" x 2"	0.50	0.50	0.75	0.75	16.00	4.00
___ 18542B3	2" x 3"	0.50	0.50	0.75	0.75	16.00	4.00
___ 18543B3	3" x 3"	0.50	0.50	0.75	0.75	16.00	4.00
___ 18543B4	3" x 4"	0.50	0.50	0.75	0.75	16.00	4.00
___ 18544B4	4" x 4"	0.50	0.50	0.50	0.50	16.00	4.00
___ 18544B6	4" x 6"	0.50	0.50	0.50	0.50	16.00	4.00
___ 18546B8	6" x 8"	0.50	0.50	0.50	0.50	16.00	4.00
___ 18548B10	8" x 10"	0.50	0.50	0.50	0.50	16.00	4.00

PROTECTOSEAL®
Safety Without Compromise
225 Foster Ave., Bensenville, IL 60106-1690
P 630.595.0800 F 630.595.8059
info@protectoseal.com www.protectoseal.com

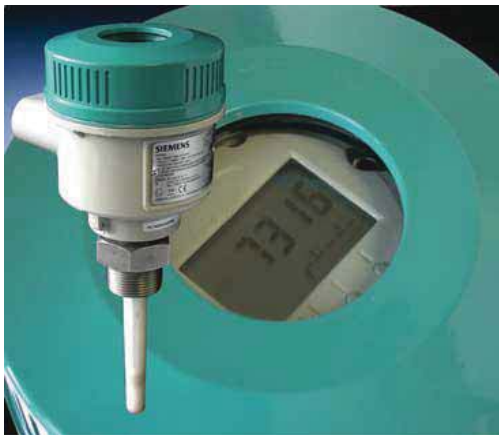
Precise and versatile

Inverse frequency shift capacitance level switch

Pointek CLS200

Answers for industry.

SIEMENS



Pointek® CLS200

Pointek CLS200 is a versatile inverse frequency shift capacitance level switch ideal for level detection of liquids, solids, slurries, foam, pump control and interfaces in general process conditions with high chemical and physical abuse. It includes Advanced Sensitive-Tip technology, ensuring high accuracy, resolution and repeatability. The digital version (with PROFIBUS PA) includes a display and provides additional diagnostic features.

- Inverse frequency shift capacitance technology results in higher accuracy and resolution
- Unique potted construction protects signal circuit from shock, vibration, humidity, and/or condensation
- Insensitive to product buildup due to high frequency oscillation
- Level detection independent of tank or pipe earth reference
- Integral LCD display allows for easy setup of CLS200 when you can configure switching threshold, even under the most demanding process conditions
- Standard version: 3 LED indicators for adjustment control, output status and power
- Advanced Sensitive-Tip technology for accurate and repeatable switch point in a wide range of liquids, solids, or slurry applications
- Online commissioning of parameters allows full advantage of the instrument: number of counts, setpoints, adjustable hysteresis, time delay, and output status. You can set up and make adjustments from the control room or other remote locations
- SIL-2 qualified for overspill protection in accordance with IEC 61508

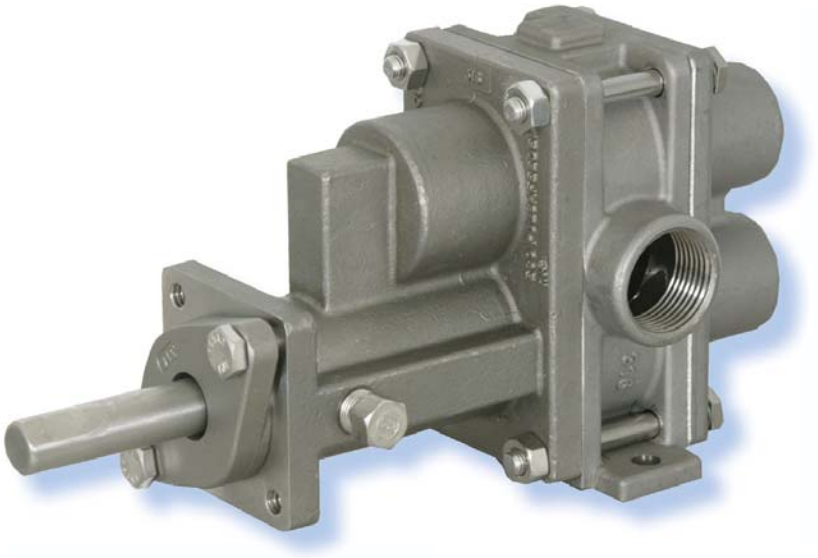
Pointek CLS200	Standard	Digital
Power		
	12 to 250 V AC/DC, 0 to 60 Hz max. 2 W	• Standard: 12 to 30 V DC, 12.5 mA • Intrinsically safe: 12 to 24 V DC, 12.5 mA
Interface		
Configuration	Locally using dip switches and potentiometers	• Remotely using SIMATIC PDM • Locally using 3 button keypad
Display	Transmitter with 3 LED indicators	Local digital LCD display
Communication		• PROFIBUS PA (IEC 61158 CPF3 CP3/2) • Bus physical layer: IEC 61158-2 MBP-(IS) • Device profile: PROFIBUS PA profile for Process Control Devices Version 3.0, Class B • FISCO field device
Output	• Relay: 1 SPDT Form C relay • Time delay: (on and/or off) controlled by user • Solid state switch	• Solid-state switch • Time delay: (on and/or off) controlled by user • Fail-safe mode
Mechanical		
Enclosure	• Epoxy coated aluminum with gasket • IP65/Type 4 /NEMA 4 (optional IP68) • Installation category: II • Pollution degree: 4	
Process connection	• 316 stainless steel (1.4404) (standard and cable) • Thermal Isolator	
Sensor	• Sensor PPS (optional: PVDF) • Max. 5.5 m (18 ft); extension 316 stainless steel (1.4404) (Standard and Sanitary) • Max. 30 m (98.4 ft) liquids and slurries; 5 m (16.4) solids (under loads); extension (stainless steel) with FEP coating (Cable)	
Process conditions		
Ambient temperature	-40 to 85 °C (-40 to 185 °F)	
Process temperature standard	• Standard -40 to 85 °C (-40 to 185 °F) • With temperature extension: -40 to 125 °C (-40 to 257 °F)	
Pressure	• Standard and rigid extension versions -1 to 25 bar g/365 psi g (nominal) • Cable version -1 to 10 bar g/150 psi g (nominal) • Optimal slide coupling version: -1 to 10 bar g/150 psi g (nominal)	
Dielectric constant ε_r	Min. 1.5	
Approvals		
	CE, CSA, FM, ATEX, SIL-2, C-TICK, WHG Overfill Protection (Germany), Lloyd's Register of Shipping, categories ENV1, ENV2, and ENV5, Pattern Approval (China)	

7ML1996-5KK03
Printed in Canada

PULSAFEEDER®

An IDEX Water & Wastewater Business

pulsafeeder.com



ECO & Isochem®
Gear Pumps

Pulsafeeder Technology

Since 1936, Pulsafeeder has been the global leader in fluid handling technology and innovation in chemical dosing. Pulsafeeder has built a foundation of success with thousands of installations in fluid handling applications. Our extensive product breadth enables us to provide the convenience and efficiency of single-source solutions across various industries.

Pulsafeeder ECO® and Isochem® Gear Pumps

Pulsafeeder gear pumps are constructed out of the strongest materials available to provide superior chemical resistance and assure long life. Designed to handle a wide range of viscosities and temperatures, the ECO and ISOCHEM gear pumps are perfect for most transfer or metering applications. Gearchem pumps offer laminar flows for consistent, continuous, measurable transfer of liquids. With Pulsafeeder's ECO and ISOCHEM pumps, you can count on years of safe, leak-free service, easy maintenance and a solid reputation for quality.

Product Specifications

- Flows to 55 gpm (208 lpm)
- Pressures to 200 psi (13.8 bar)
- Accuracy of +/-5% of flow with repeatability of +/-2%
- Fluid Temperatures of -40°F to 450°F (-40°C to 232°C)
- Viscosity up to 1,000,000 cPs
- Minimum Suction NPSHR of 1 to 2ft

*All shaft materials can be hard coated for superior abrasion resistance. Standard with Silicon Carbide bearing selection.

Materials of Construction

- *Casing/Housing materials*: 316SSL, 316SS, Alloy C, Alloy 20
- *Drive and Idler Gear materials:* 316SSL, 316SS, Alloy C, Alloy 20, TFE (Glass-Filled), PEEK
- *Bearing materials:* Carbon 72, Carbon 92, Glass-filled PTFE, Silicon Carbide
- *Wearplate materials:* Carbon 72, Ceramic, Glass-filled PTFE, PEEK
- *Shaft materials*:* 316SSL, 316SS, Alloy 20, Alloy C

Typical Applications

- Adhesives and Resins
- Catalysts
- Odor Control Additives
- Fertilizers
- Polymers
- Flocculants
- Caustics
- Hydrochloric Acid
- Solvents
- Biocides
- Dyes and Bleaching chemicals
- Detergents
- Many More

ECO® & Isochem®

Flow and Pressures Specifications

SERIES	MAX FLOW GPM (LPM)	MAX WORKING PRESSURE PSI (BAR)
2	1.5 (6)	200 (14)
4	3 (11)	200 (14)
6	10 (38)	150 (10)
8	22 (83)	150 (10)
H6	10 (38)	250 (17)
H8	22 (83)	200 (14)
12*	28 (106)	200 (14)
16*	60 (227)	200 (14)

* Consult factory for extended flows and their materials of constructions.

Theory of Operation

Gear pumps are frequently relied upon for product transfer. They can handle both high and low viscosity and high and low temperature fluids including liquefied gasses. Typically they are employed to transfer fluids from vehicles to storage tanks or from tank to tank.

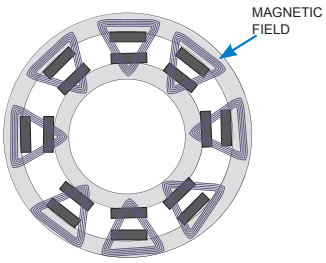
The advantage of utilizing gear pumps in metering is based in its consistency. Feedback from flow meters and sensors can control motor speed to maintain a steady consistent flow regardless of changes in viscosity, pressure or temperature. When you control the motor, you control the output.

Gear Pump Technology

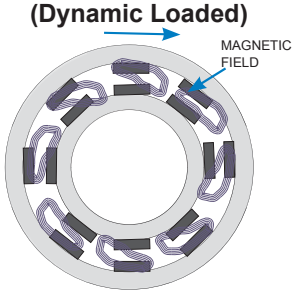
ECO® TECHNOLOGY

At the heart of each ECO Gearchem pump are two tightly toleranced, machine-generated spur gears-a drive and an idler gear. Self priming capability is accomplish by our closely toleranced gears which seal tightly to evacuate air from the suction piping. Gearchem pumps provide linear, laminar flows. The pumps are bidirectional which lets your easily change flow direction.

MAGNETIC COUPLING
(Static-No Load)



MAGNETIC COUPLING
(Dynamic Loaded)



Isochem® TECHNOLOGY

The science behind Isochem centers on sealless magnetic technology which results in a completely leak-free pump. The drive magnet is fixed to the motor shaft and works in conjunction with the driven magnet. As the pump is engaged, the drive magnet begins its rotation and pulls the driven magnet along due to the magnetic force. As the shaft is completely contained, there is no possibility of fluid leakage and therefore no need for mechanical seals. The permanent magnet material is available in either neodymium iron or rare earth samarium cobalt. The torque capacity of both are incredibly high and virtually eliminates any possibility of coupling slippage.

ECO® & Isochem® CONFIGURATIONS

The ECO family is available in the following models: G2, GA2, G4, GA4, G6, GA6, GH6, G8, GA8, GH8, GA12 and GA16.

GA2

GA4

GA8

ECO GC2
Closed Coupled

ECO GC4
Closed Coupled

ECO GC8
Closed Coupled

The ISOCHEM family is available in the following models: GMC1, GMC2, GMC4, GMC6, GMH6, GMC8, GMH8, GM12 and GM16.

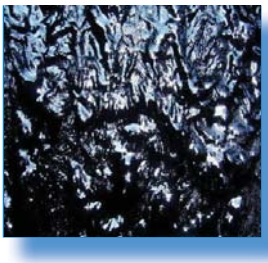
GMC2

GMC4

GMH8

Features and Benefits

ECO®



Can Handle a Variety of Fluid Viscosities

- Extensive material availability provides versatility for pumping low or high viscosity fluids
- Can handle clear lubricating and non-lubricating fluids including hydrocarbons and polymer 0.8 to 1,000,000 cPs

Three Types of Seal and Packing Arrangements

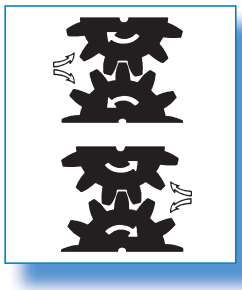
- Internal mechanical seals (single or double)
- External mechanical seals (for pressure or vacuum service)
- Packing (standard or lantern ring)

Replaceable Wearplates Restore ECO to "Like New" Performance

- Easily replaceable
- Available in a variety of materials including carbon, PTFE (glass-filled), PEEK and ceramic.
- Prevents gears from coming into contact with the housing

Internal Sleeve Type Bearings

- Lubricated by the process fluid
- No risk of contamination from external lubrication materials
- Offered in glass-filled PTFE, carbon graphite impregnated, carbon graphite impregnated sintered for hardness and to extend life-also available is Silicon Carbide (sintered).



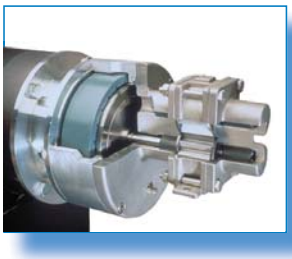
Self-Priming* and Bi-Directional

- Closed running and operating clearances evacuate air from the suction piping
- Pumps are bi-directional for ease of installation
- Suction and discharge ports are dependent upon motor wiring and shaft rotation
- Flow direction can be reversed by changing motor direction

* After initial priming (wetted)

Features and Benefits

Isochem®



Magnetic Coupling Eliminates Mechanical Seals

- Magnetic Drive Technology eliminates leakage of hazardous, toxic, and corrosive chemicals
- Downtime and maintenance costs are reduced as there are no worn seals to replace
- Eliminates costly seal flush systems required with all pumps with double mechanical seals

Superior Corrosion Resistance and Long Life

- 316SS, Alloy 20 and Alloy C housing provide maximum chemical resistance
- Alternate gear, bearing, and wearplate materials for maximizing pump life and compatibility

Minimizes Heating

- Reduced eddy heating current with optional Alloy C containment can
- Designed with recirculation wearplates and bearings
- Positive lubrication groves in bearings help to reduce heat caused by friction
- One piece containment can eliminates any chance for leakage

Closed Coupled Design

- Eliminates the alignment problems that are inherent in long coupled base units
- Close coupled mounting for NEMA C-Face and IEC B14 (B34) motors
- Laser alignment equipment is not required
- Reduce overall pump and motor footprint

Compact and Self-Priming

- Compact size makes pumps ideal for a variety of footprints
- Self-priming and reliable
- Manufactured to close tolerances to assure repeatable performance

Control Options

MPC VECTOR

The MPC Vector is a microprocessor based motor speed control device, for use with all pump technologies and has been designed for simplicity, yet has many advanced features that allow a wide variety of environments and applications. The product is not just a variable speed drive, rather it is a state of the art multifunctional controller.

- Sensorless, vector type drive
- Wide range of flow control
- Infinite turndown with the appropriate motor
- Displays flow in GPH, LPH, GPM, or LPM
- Displays speed in RPM
- Display can be set in one of five programmable languages
- NEMA 4X (IP56) rating on the control and handheld key-pad enclosures
- Can be mounted up to 1000ft (304m)
- Security code to lock out unauthorized users
- Input, output processor (4-20 mA and digital)
- PID loop for closed loop flow control

Use the MPC Vector to Monitor:

- Supply tank level
- Pump flow verification
- Remote status indication of pump (on/off)
- Pump alarm status
- Pump auto/manual status

Pump Options

In addition to the material offerings for ECO and Isochem pumps, there are a variety of options that allow you to customize your ECO or Isochem pump to meet the application specifications. Not shown but also available are flush ports and pedestal assemblies.

Base Mounted Units: Both pumps can be mounted on formed bases of heavy-gauge carbon or stainless steel. These complete units provide easy installation.

Close coupled ECO Gearchem pumps provide a compact alterative to limited space requirements. The one piece design affords simple installation, eliminates misalignments, and is inherent safe for rotating components.

Bolt-On Thermal Jackets help to regulate the pumping temperature of the process liquid. The jackets are designed to conform closely to pump contours to transfer heat evenly.

Flanged Ports: Raised faced 150lb ANSI flanges are available on the suction and discharge ports of both Isochem and ECO. They are available in all sizes (excluding GMC1).

Systems

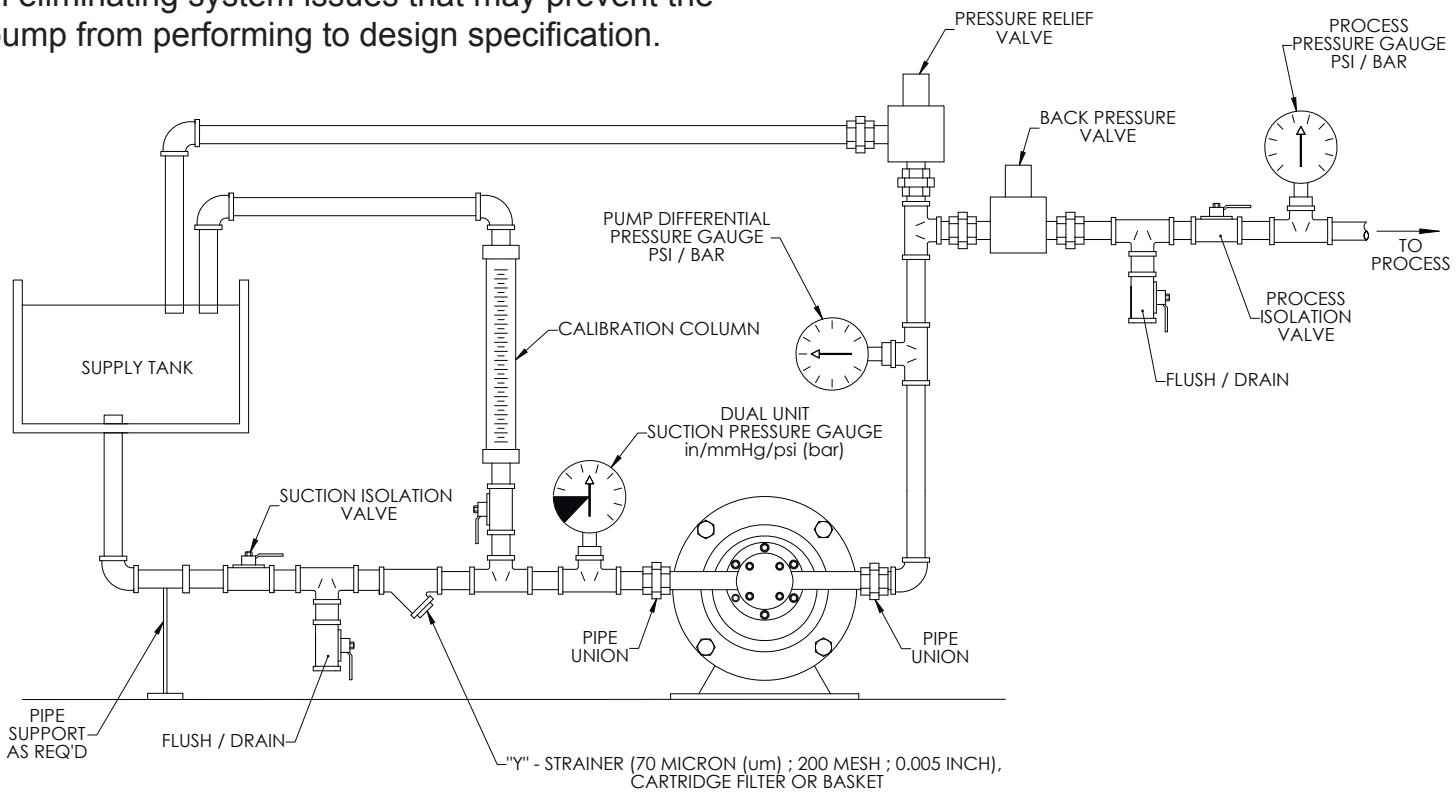
Utilizing ECO GA12 Flanged Pump to pump resin.

ISOCHEM GMC4

Canadian municipal water treatment plants rely upon Isochem to keep their water supply clean.

RECOMMENDED INSTALLATION

Accessories and instrumentation are essential in eliminating system issues that may prevent the pump from performing to design specification.



Parts & Accessories

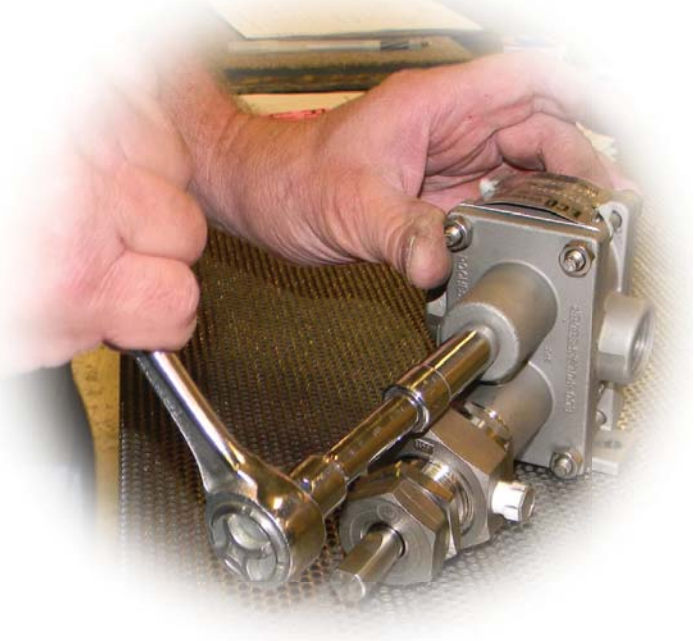
pulsafeeder.com PULSAFEEDER GENUINE PARTS

A **KOPkit® (Keep On Pumping)** can help you cut downtime and put you back in business fast. Use KOPkits for preventive maintenance and to ensure continuous high performance from your Pulsafeeder metering pump.

Pressure Relief Valves prevent an overpressurization situation from ever damaging your pumps or pumping system. Overpressurization can occur when a valve is closed or a blockage occurs. They are always recommended equipment for any pump or skid system.

MPC Vector
A state of the art multi-functional controller that utilizes a sensorless vector motor control technology.

Pedestals and Base Mounts help to provide proper alignment of the pump with the motor. They provide stability, strength, and assure proper positioning.



Y-Strainers arrest out debris in pipelines, protecting equipment and processes. They prevent premature wear of the rotating components within a pump.

Calibration Columns
These columns are constructed of clear PVC tubes with PVC end caps or an option for Borosilicate glass with Teflon end caps and should be sized for a 30-second draw down.

Pressure Gauges are relied on to measure pressure in the system. Proper pressure is necessary to ensure flow. Pulsafeeder Pressure Gauges are accurate and reliable.

Back Pressure Valves provide positive back pressure for systems with less than the minimum required pressure difference between the discharge and suction side of the metering pump. They assure optimum metering performance.

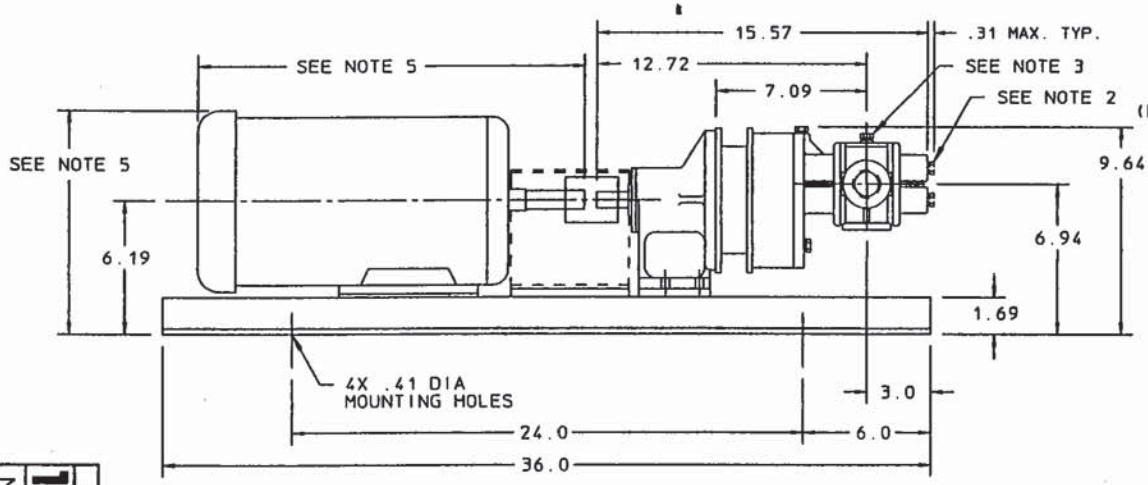
PULSAFEEDER
2883 Brighton Henrietta TL Rd
Rochester, NY 14623
Phone: ++1(585) 292-8000
Fax: ++1 (585) 424-5619

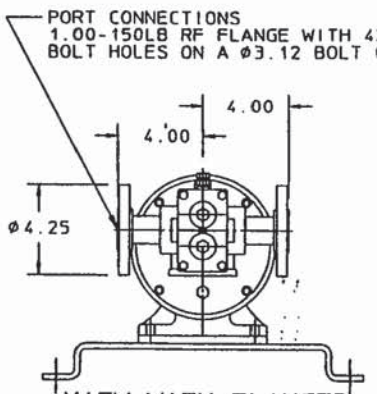
An IDEX Water & Wastewater Business IDEX

An ISO 9001 and ISO 14001 Certified Company

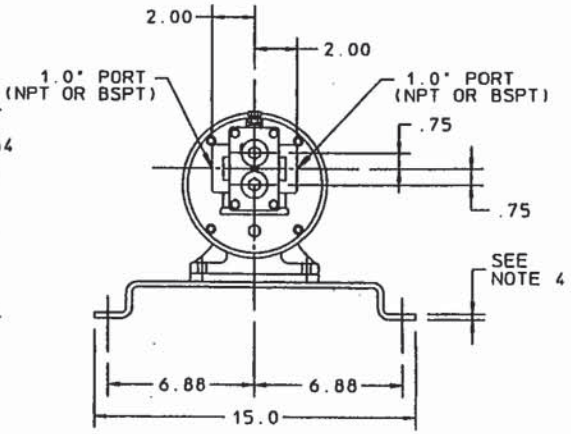
REF	REVISION UPDATE	DATE
A	ADDED FLANGED VIEW	03/27/01

SECTION/PAGE
EFFECTIVE
SUPERSEDES
MODEL GM8 / 305
03/27/01
04/01/98





VIEW WITH FLANGED
CENTER HOUSING



NOTES:

1. SUCTION AND DISCHARGE PORTS ARE DEPENDENT UPON PUMP SHAFT ROTATION.
2. BEARING FLUSH AND DRAIN PLUGS (.12 NPT) ARE OPTIONAL.
3. VENT PLUG (.12 NPT) OPTIONAL.
4. MATERIAL THICKNESS:
   STEEL .25 THK.
   STAINLESS STEEL .19 THK.
5. MOTOR DIMENSIONS VARY BY MANUFACTURER. CONSULT MANUFACTURER'S DRAWING FOR SPECIFICS.

ALL DIMENSIONS ARE IN INCHES

Ingersoll-Rand
FLOW CONTROL
A Unit of IR Corporation

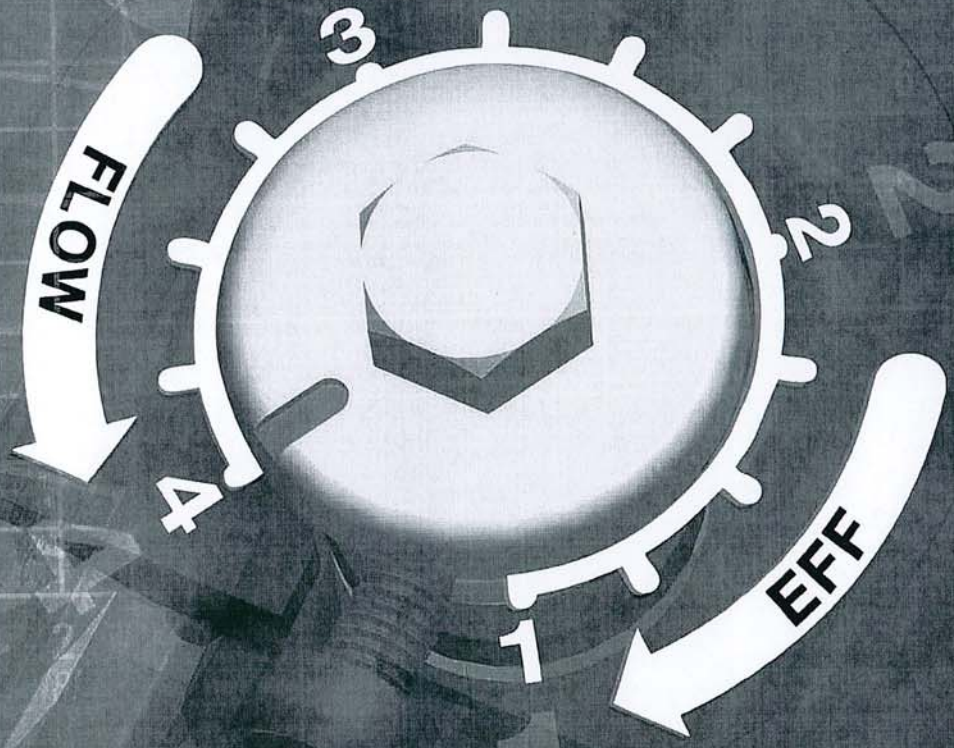
MODEL GM8/GMC8
MTD BASE AND PEDESTAL
182-184T FRAME MOTORS

DWN BY: JEM JR
DATE: 10/27/89

SD2682

PX400
METAL

WILDEN
A DOVER COMPANY

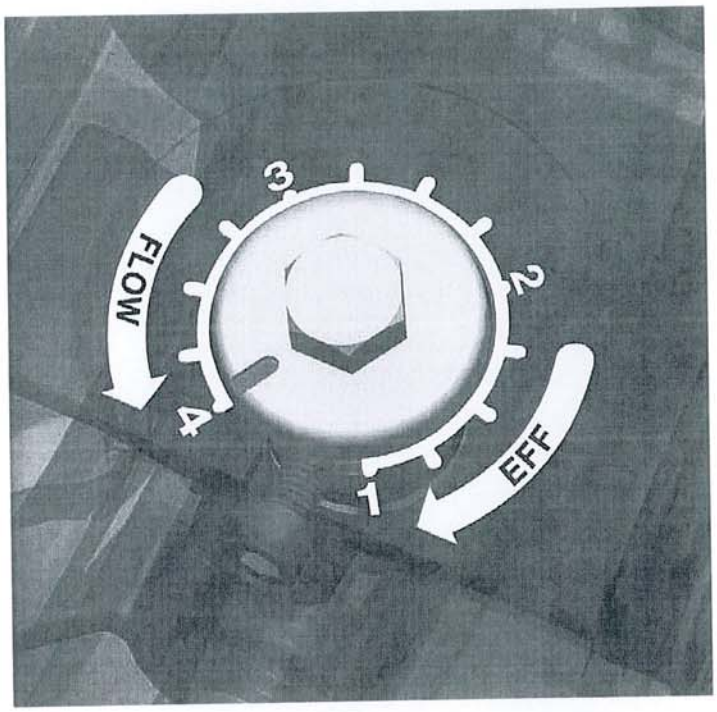


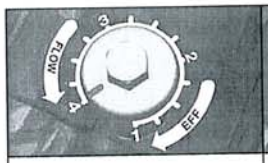
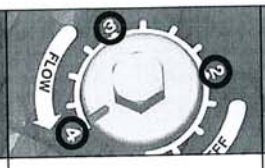
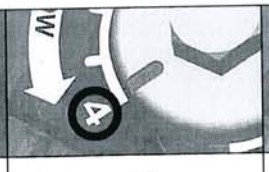
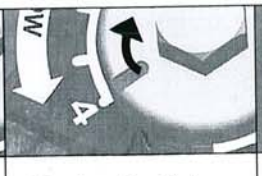
PRO-FLO™ X
PROGRESSIVE PUMP TECHNOLOGY

PX400 PERFORMANCE

Pro-Flo X™ Operating Principal

The Pro-Flo X™ air distribution system with the revolutionary Efficiency Management System (EMS) offers flexibility never before seen in the world of AODD pumps. The patent-pending EMS is simple and easy to use. With the turn of an integrated control dial, the operator can select the optimal balance of flow and efficiency that best meets the application needs. Pro-Flo X™ provides higher performance, lower operational costs and flexibility that exceeds previous industry standards.



				
Turning the dial changes the relationship between air inlet and exhaust porting.	Each dial setting represents an entirely different flow curve	Pro-Flo X™ pumps are shipped from the factory on setting 4, which is the highest flow rate setting possible	Moving the dial from setting 4 causes a decrease in flow and an even greater decrease in air consumption.	When the air consumption decreases more than the flow rate, efficiency is improved and operating costs are reduced.

Example 1

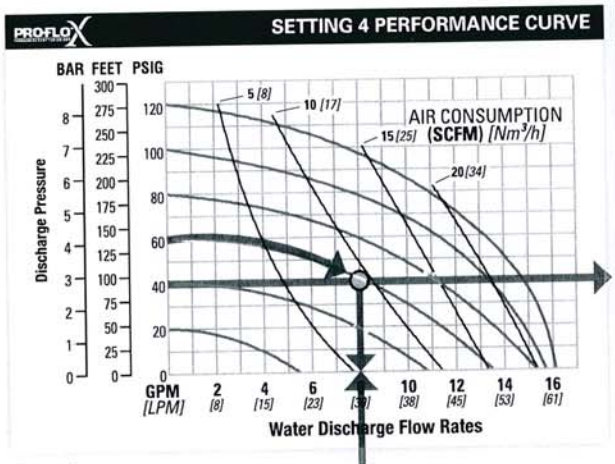


Figure 1

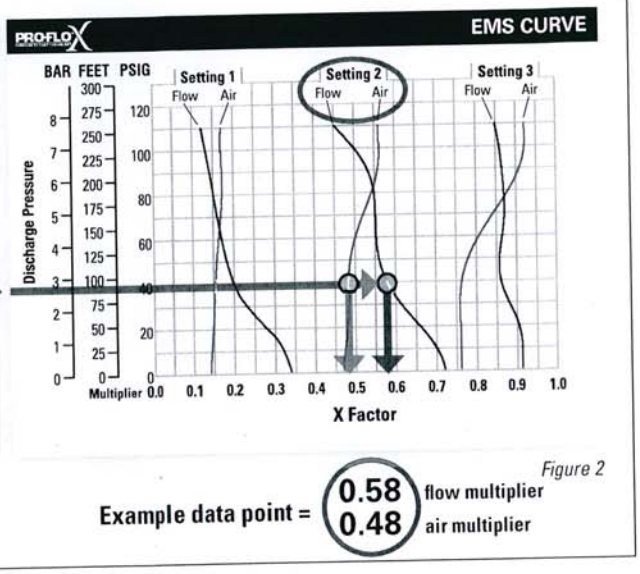


Figure 2

This is an example showing how to determine flow rate and air consumption for your Pro-Flo X™ pump using the Efficiency Management System (EMS) curve and the performance curve. For this example we will be using 4.1 bar (60 psig) inlet air pressure and 2.8 bar (40 psig) discharge pressure and EMS setting 2.

Step 1: ***Identifying performance at setting 4.*** Locate the curve that represents the flow rate of the pump with 4.1 bar (60 psig) air inlet pressure. Mark the point where this curve crosses the horizontal line representing 2.8 bar (40 psig) discharge pressure. (Figure 1). After locating your performance point on the flow curve, draw a vertical line downward until reaching the bottom scale on the chart. Identify the flow rate (in this case, 8.2 gpm). Observe location of performance point relative to air consumption curves and approximate air consumption value (in this case, 9.8 scfm).

Step 2: ***Determining flow and air X Factors.*** Locate your discharge pressure (40 psig) on the vertical axis of the EMS curve (Figure 2). Follow along the 2.8 bar (40 psig) horizontal line until intersecting both flow and air curves for your desired EMS setting (in this case, setting 2). Mark the points where the EMS curves intersect the horizontal discharge pressure line. After locating your EMS points on the EMS curve, draw vertical lines downward until reaching the bottom scale on the chart. This identifies the flow X Factor (in this case, 0.58) and air X Factor (in this case, 0.48).

Step 3: ***Calculating performance for specific EMS setting.*** Multiply the flow rate (8.2 gpm) obtained in Step 1 by the flow X Factor multiplier (0.58) in Step 2 to determine the flow rate at EMS setting 2. Multiply the air consumption (9.8 scfm) obtained in Step 1 by the air X Factor multiplier (0.48) in Step 2 to determine the air consumption at EMS setting 2 (Figure 3).

8.2	gpm	*(flow rate for Setting 4)*
.58		*(Flow X Factor setting 2)*
4.8	gpm	*(Flow rate for setting 2)*
9.8	scfm	*(air consumption for setting 4)*
.48		*(Air X Factor setting 2)*
4.7	scfm	*(air consumption for setting 2)*

Figure 3

The flow rate and air consumption at Setting 2 are found to be 18.2 lpm (4.8 gpm) and 7.9 Nm³/h (4.7 scfm) respectively.

Example 2.1

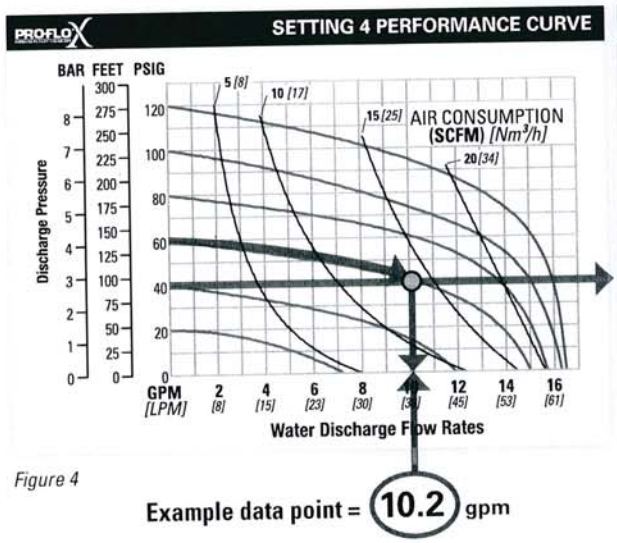


Figure 4

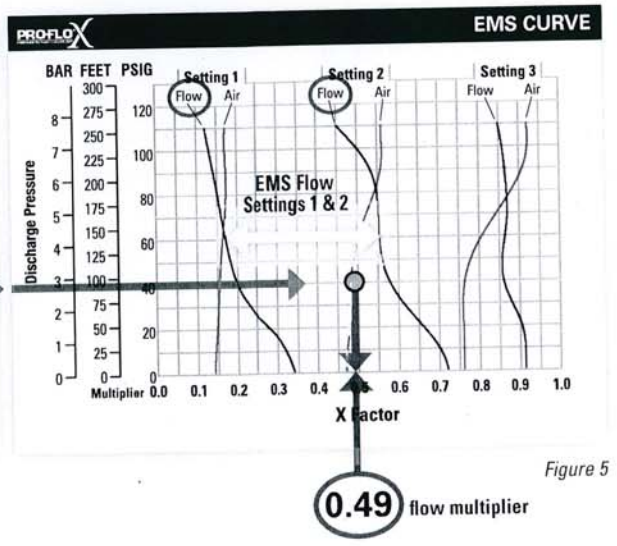


Figure 5

This is an example showing how to determine the inlet air pressure and the EMS setting for your Pro-Flo X™ pump to optimize the pump for a specific application. For this example we will be using an application requirement of 18.9 lpm (5 gpm) flow rate against 2.8 bar (40 psig) discharge pressure. This example will illustrate how to calculate the air consumption that could be expected at this operational point.

DETERMINE EMS SETTING

Step 1: ***Establish inlet air pressure.*** Higher air pressures will typically allow the pump to run more efficiently, however, available plant air pressure can vary greatly. If an operating pressure of 6.9 bar (100 psig) is chosen when plant air frequently dips to 6.2 bar (90 psig) pump performance will vary. Choose an operating pressure that is within your compressed air systems capabilities. For this example we will choose 4.1 bar (60 psig).

Step 2: ***Determine performance point at setting 4.*** For this example an inlet air pressure of 4.1 bar (60 psig) inlet air pressure has been chosen. Locate the curve that represents the performance of the pump with 4.1 bar (60 psig) inlet air pressure. Mark the point where this curve crosses the horizontal line representing 2.8 bar (40 psig) discharge pressure. After locating this point on the flow curve, draw a vertical line downward until reaching the bottom scale on the chart and identify the flow rate. In our example it is 38.6 lpm (10.2 gpm). This is the setting 4 flow rate. Observe the location of the performance point relative to air consumption curves and approximate air consumption value. In our example setting 4 air consumption is 24 Nm³/h (14 scfm). See figure 4.

Step 3: ***Determine flow X Factor.*** Divide the required flow rate 18.9 lpm (5 gpm) by the setting 4 flow rate 38.6 lpm (10.2 gpm) to determine the flow X Factor for the application.

5 gpm / 10.2 gpm = 0.49 (flow X Factor)

Step 4: ***Determine EMS setting from the flow X Factor.*** Plot the point representing the flow X Factor (0.49) and the application discharge pressure 2.8 bar (40 psig) on the EMS curve. This is done by following the horizontal 2.8 bar (40 psig) psig discharge pressure line until it crosses the vertical 0.49 X Factor line. Typically, this point lies between two flow EMS setting curves (in this case, the point lies between the flow curves for EMS setting 1 and 2). Observe the location of the point relative to the two curves it lies between and approximate the EMS setting (figure 5). For more precise results you can mathematically interpolate between the two curves to determine the optimal EMS setting.

For this example the EMS setting is 1.8.

Example 2.2

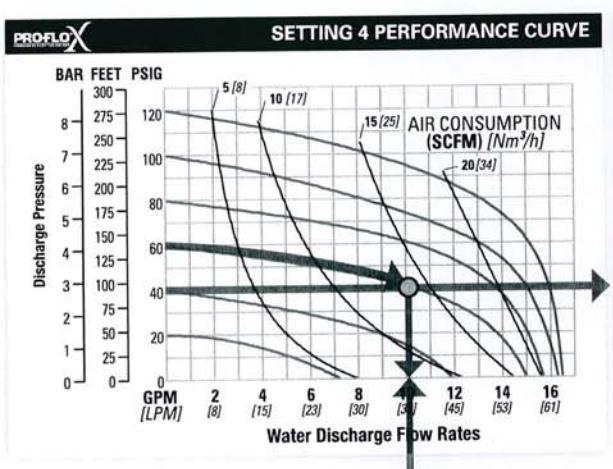


Figure 6

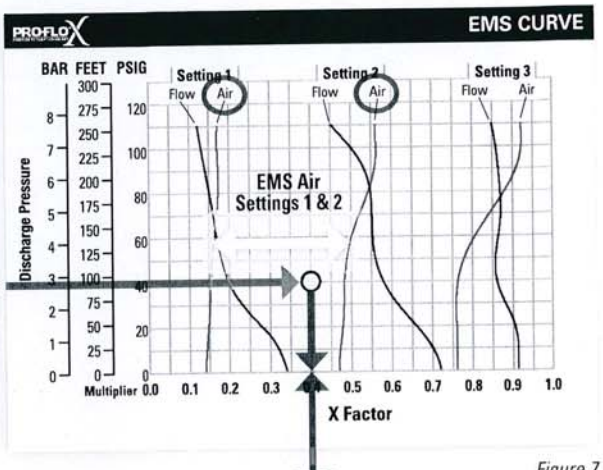


Figure 7

Determine air consumption at a specific EMS setting.

Step 1: ***Determine air X Factor.*** In order to determine the air X Factor, identify the two air EMS setting curves closest to the EMS setting established in example 2.1 (in this case, the point lies between the air curves for EMS setting 1 and 2). The point representing your EMS setting (1.8) must be approximated and plotted on the EMS curve along the horizontal line representing your discharge pressure (in this case, 40 psig). This air point is different than the flow point plotted in example 2.1. After estimating (or interpolating) this point on the curve, draw a vertical line downward until reaching the bottom scale on the chart and identify the air X Factor (figure 7).

For this example the air X Factor is **0.40**

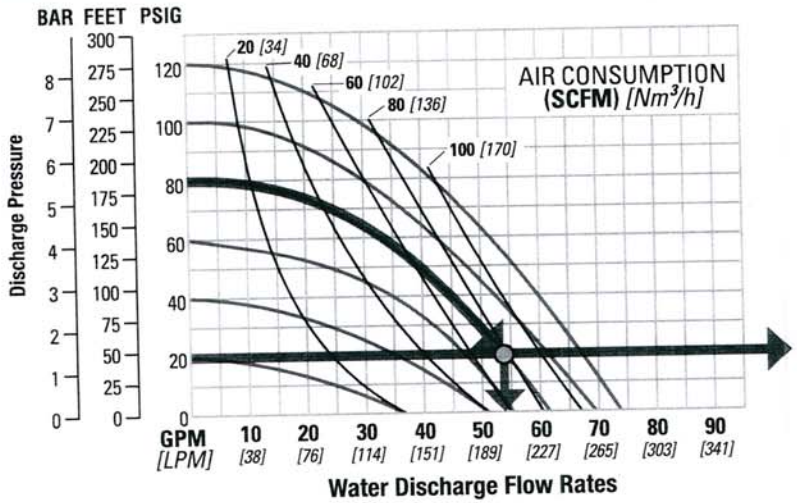
Step 2: ***Determine air consumption.*** Multiply your setting 4 air consumption (14 scfm) value by the air X Factor obtained above (0.40) to determine your actual air consumption.

14 scfm x **0.40** = 5.6 SCFM

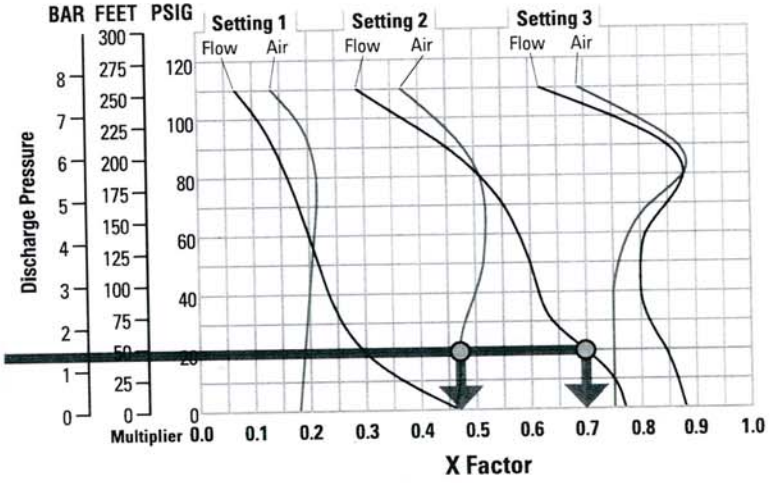
In summary, for an application requiring 18.9 lpm (5 gpm) against 2.8 bar (40 psig) discharge pressure, the pump inlet air pressure should be set to 4.1 bar (60 psig) and the EMS dial should be set to 1.8. The pump would then consume 9.5 Nm^3/h (5.6 scfm) of compressed air.

PX400 STAINLESS STEEL – PTFE-FITTED

SETTING 4 PERFORMANCE CURVE



EMS CURVE



TECHNICAL DATA

Height	528 mm (20.8")
Width	384 mm (15.1")
Depth	310 mm (12.2")
Ship Weight	316 Stainless Steel 43 kg (94 lbs.)
	Alloy C45 kg (100 lbs.)
Air Inlet	19 mm (3/4")
Inlet	38 mm (1-1/2")
Outlet	38 mm (1-1/2")
Suction Lift	3.6 m Dry (11.9')
	9.0 m Wet (29.5')
Disp. Per Stroke	0.5 l (0.14 gal.)1
Max. Flow Rate	280 lpm (74 gpm)
Max. Size Solids	4.8 mm (3/16")

[1]Displacement per stroke was calculated at 4.8 bar (70 psig) air inlet pressure against a 2 bar (30 psig)head pressure.

The Efficiency Management System (EMS) can be used to optimize the performance of your Wilden pump for specific applications. The pump is delivered with the EMS adjusted to setting 4, which allows maximum flow.

The EMS curve allows the pump user to determine flow and air consumption at each EMS setting. For any EMS setting and discharge pressure, the "X factor" is used as a multiplier with the original values from the setting 4 performance curve to calculate the actual flow and air consumption values for that specific EMS setting. Note: you can interpolate between the setting curves for operation at intermediate EMS settings.

EXAMPLE

A PX400 stainless steel, PTFE-fitted pump operating at EMS setting 4, achieved a flow rate of 204 lpm (54 gpm) using 133 Nm³/h (78 scfm) of air when run at 5.5 bar (80 psig) air inlet pressure and 1.4 bar (20 psig) discharge pressure (See dot on performance curve).

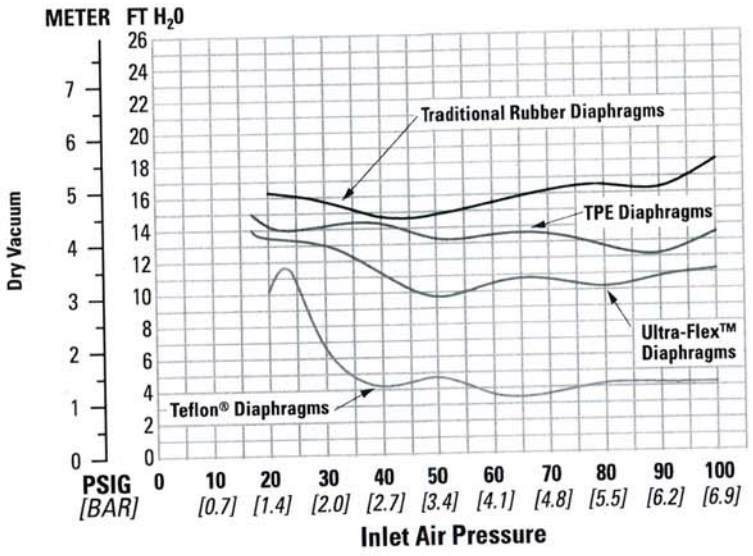
The end user did not require that much flow and wanted to reduce air consumption at his facility. He determined that EMS setting 2 would meet his needs. At 1.4 bar (20 psig) discharge pressure and EMS setting 2, the flow "X factor" is 0.70 and the air "X factor" is 0.47 (see dots on EMS curve).

Multiplying the original setting 4 values by the "X factors" provides the setting 2 flow rate of 143 lpm (38 gpm) and an air consumption of 62 Nm³/h (37 scfm). The flow rate was reduced by 30% while the air consumption was reduced by 53%, thus providing increased efficiency.

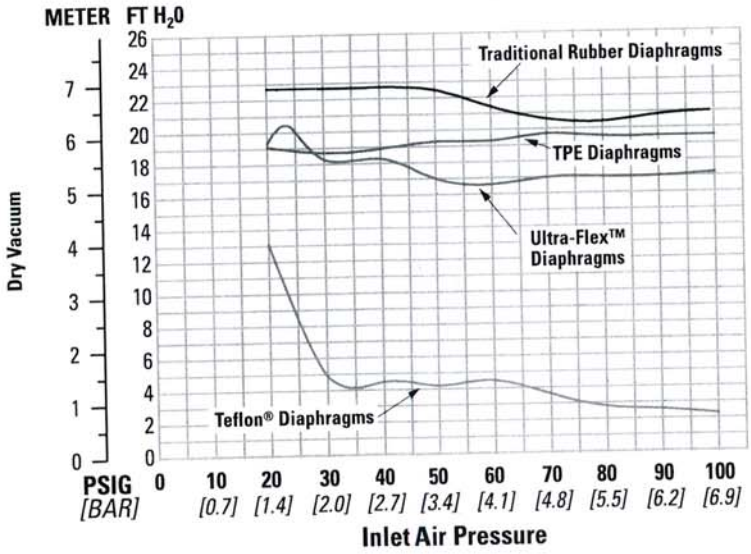
For a detailed example for how to set your EMS, see beginning of performance curve section.

Caution: Do not exceed 8.6 bar (125 psig) air supply pressure.

PX400 ALUMINUM SUCTION LIFT CAPABILITY



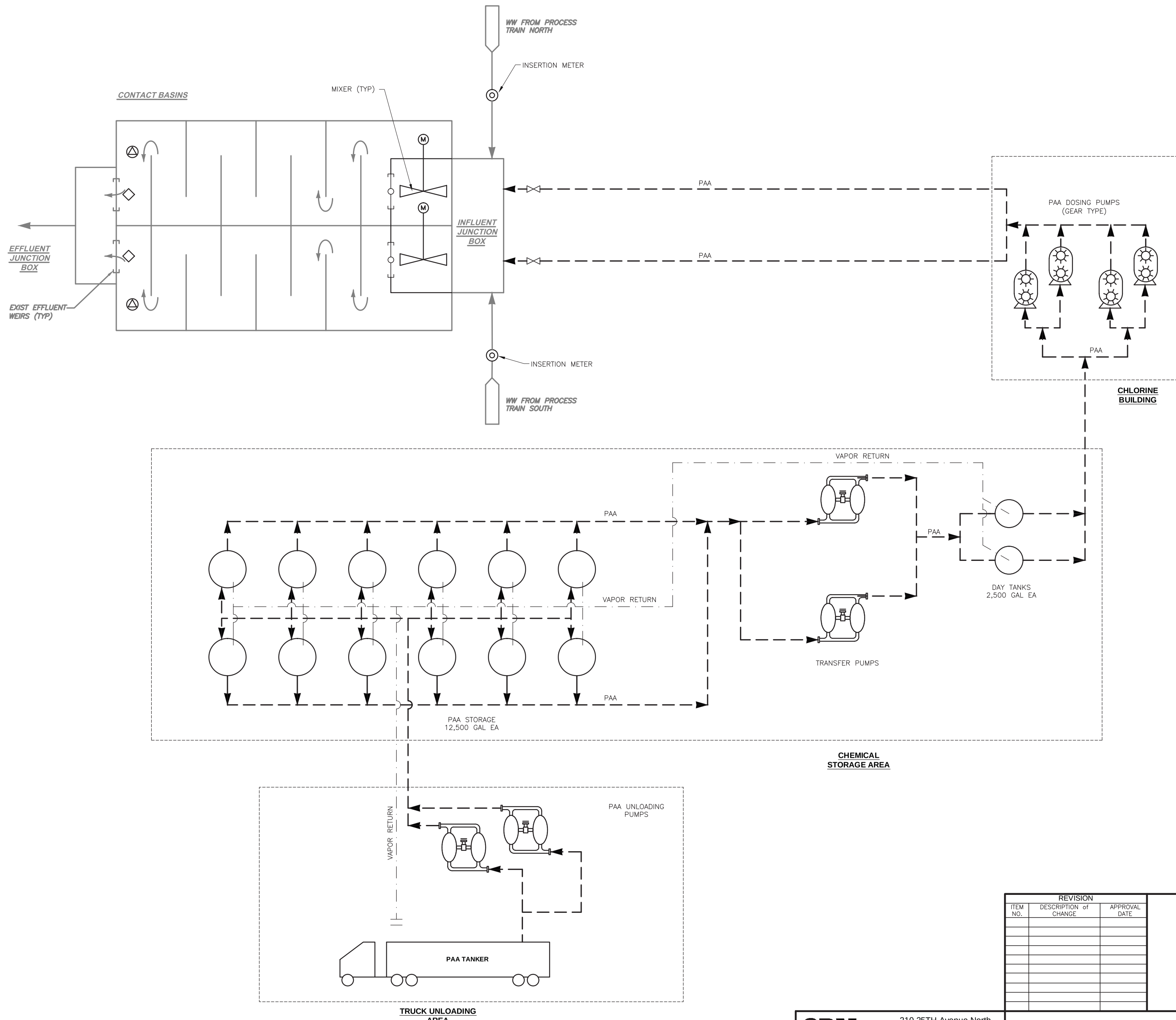
PX400 STAINLESS STEEL & ALLOY C SUCTION LIFT CAPABILITY



Suction lift curves are calibrated for pumps operating at 305 m (1,000') above sea level. This chart is meant to be a guide only. There are many variables which can affect your pump's operating characteristics. The number of intake and discharge elbows, viscosity of pumping fluid, elevation (atmospheric pressure) and pipe friction loss all affect the amount of suction lift your pump will attain.

Appendix C

30% Construction Drawings



GENERAL INFORMATION	
WASTEWATER FLOWS (MGD)	
MINIMUM FLOW	58 MGD
AVERAGE DAILY FLOW (ADF)	135 MGD
PEAK FLOW	250 MGD
DISINFECTION	
DISINFECTION BASIN	
QUANTITY	2
DETENTION TIME AT PEAK FLOW (MIN)	15
EXISTING CAPACITY AVAILABLE (GAL)	2,610,000
PAA STORAGE TANKS	
DAYS OF STORAGE	16
QUANTITY	12
CAPACITY (GAL)	12,500 (EA.)
% CONCENTRATION	15%
PAA DAY TANKS	
QUANTITY	2
TOTAL CAPACITY (GAL)	2,500 (EA.)
PAA METERING PUMPS	
QUANTITY	4 (2 DUTY, 2 STANDBY)
TYPE	GEAR
AVERAGE DOSAGE	12.1 MG/L
MAXIMUM DOSAGE	16 MG/L
PUMP TURN DOWN	12:1
UNLOADING AND TRANSFER PUMPS	
NO. PAA UNLOADING AND TRANSFER PUMPS	4
TYPE	AIR OPERATED DIAPHRAGM
CAPACITY (GPM)	50 GPM (EA)

NOTES:

1. MIXERS, TANKS, CHEMICAL FEED AND TRANSFER PUMPS AND PIPING WILL BE SUPPLIED BY PAA PROVIDER.

LEGEND

- CHEMICAL LINES
- VAPOR RETURN
- *EXISTING LIQUID PROCESS*
- PAA RESIDUAL ANALYZER
- SECONDARY FLOW MEASUREMENT
- INSERTION METER

REVISION		
ITEM NO.	DESCRIPTION of CHANGE	APPROVAL DATE

CDM Smith
210 25TH Avenue North
Suite 1102
Nashville, TN 37203
Tel: (615) 3203161

MAYNARD C. STILES WWTP

DISINFECTION IMPROVEMENTS

DRAWING: G-01 SHEET X OF XX

MEMPHIS LIGHT GAS AND WATER

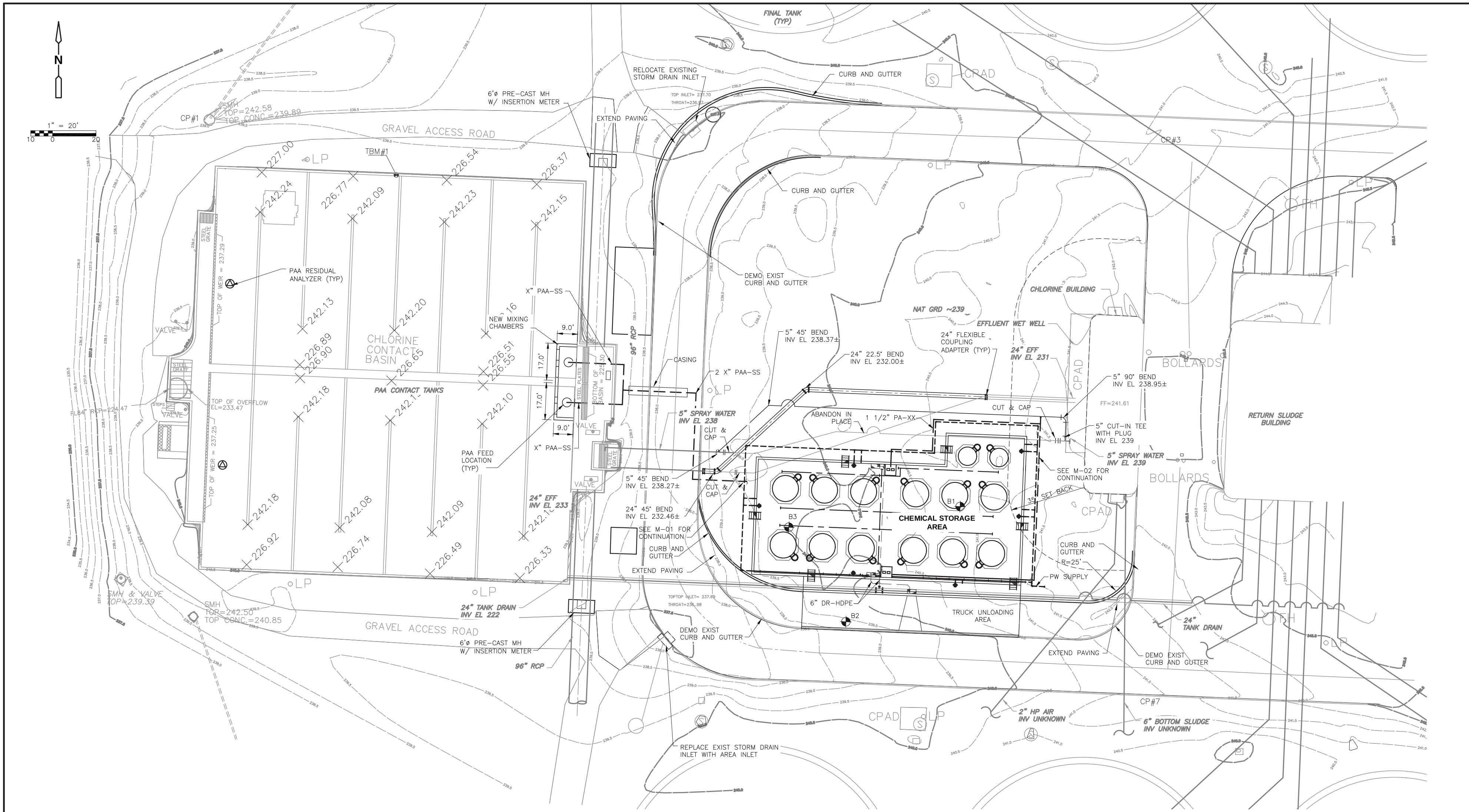
PROCESS FLOW DIAGRAM

MEMPHIS, TN

SURVEY DATE BOOK
DRAWN BY CEZEAUX DATE SEP 2014 SCALE NTS
DESIGN BY GRISSOM DATE SEP 2014 PROJECT 6016-83104
REVIEWED
DEP. CITY ENGINEER DATE CITY ENGINEER DATE

60% SUBMITTAL - NOT FOR CONSTRUCTION

XREFs: [CDMS_2234] Images: []
Last saved by: CEZEAUXJS Time: 1/22/2014 3:56:54 PM
pw:\\docpwapp1:PW_XM1\6016\83104\04 Design Services NM_30%\01 General\10 CADD\G001PRFD.dwg



LEGEND

- - - - - CHEMICAL LINES

PAA RESIDUAL ANALYZER

PROPOSED BORING LOCATIONS

REVISION		
ITEM NO.	DESCRIPTION of CHANGE	APPROVAL DATE

CDM Smith
210 25TH Avenue North
Suite 1102
Nashville, TN 37203
Tel: (615) 3203161

MAYNARD C. STILES WWTP

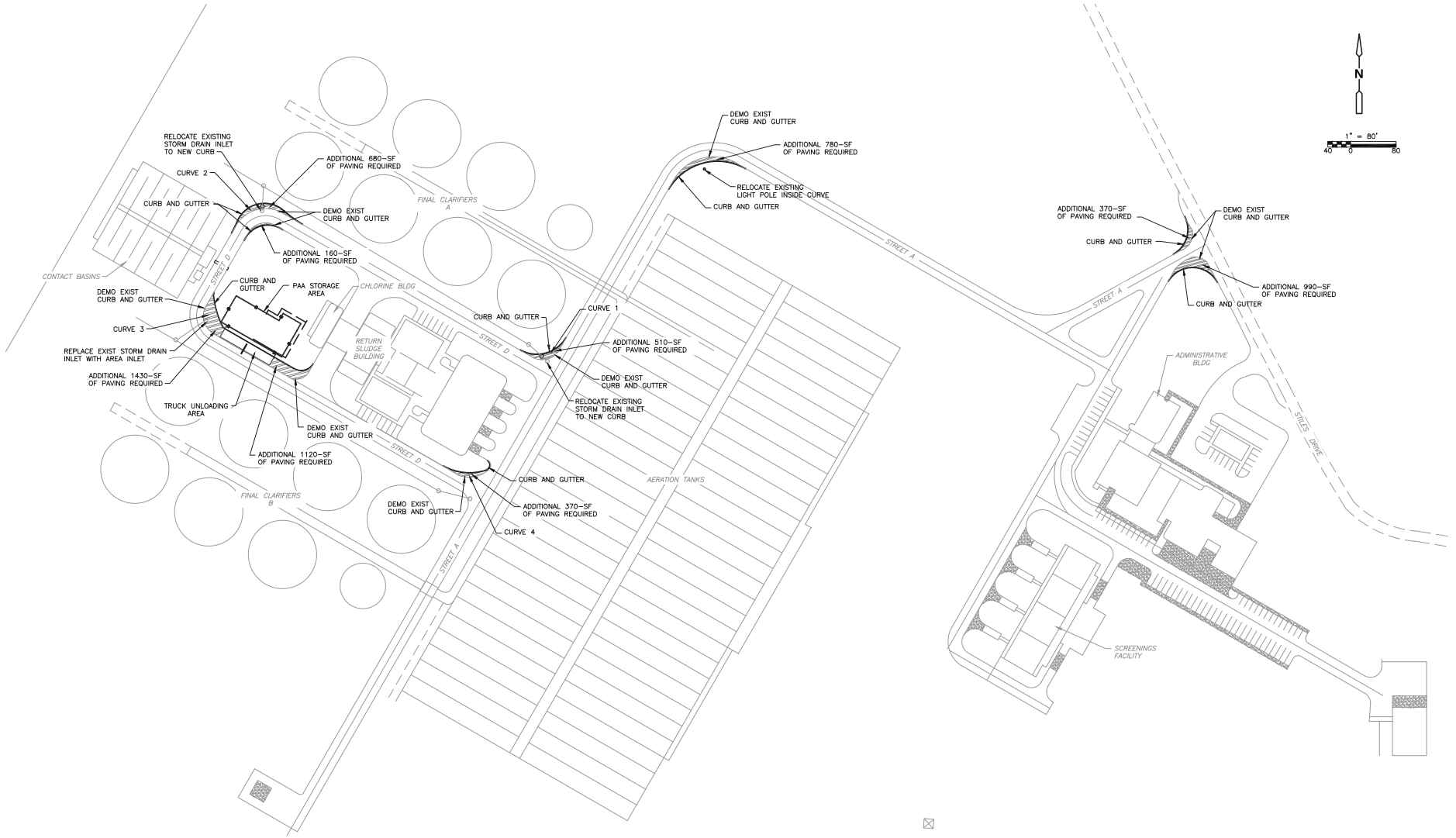
DISINFECTION IMPROVEMENTS

DRAWING: **C-01** SHEET X OF XX

MEMPHIS LIGHT GAS AND WATER
CHEMICAL STORAGE AREA
SITE PLAN
MEMPHIS, TN

SURVEY ____ DATE ____ BOOK ____
DRAWN BY CEZEAUX DATE SEP 2014 SCALE 1"=20'
DESIGN BY GRISSOM DATE SEP 2014 PROJECT 6016-83104
REVIEWED
DEP. CITY ENGINEER DATE CITY ENGINEER DATE

60% SUBMITTAL - NOT FOR CONSTRUCTION



REVISION		
ITEM NO.	DESCRIPTION of CHANGE	APPROVAL DATE

DISINFECTION IMPROVEMENTS

DRAWING: **C-02** SHEET X OF XX

MEMPHIS LIGHT GAS AND WATER

PAVEMENT IMPROVEMENTS

MEMPHIS, TN

SURVEY		DATE	BOOK
DRAWN BY	CEZEAUX	DATE JAN 2014	SCALE 1"=80'
DESIGN BY	GRISSOM	DATE JAN 2014	PROJECT 6016-83104

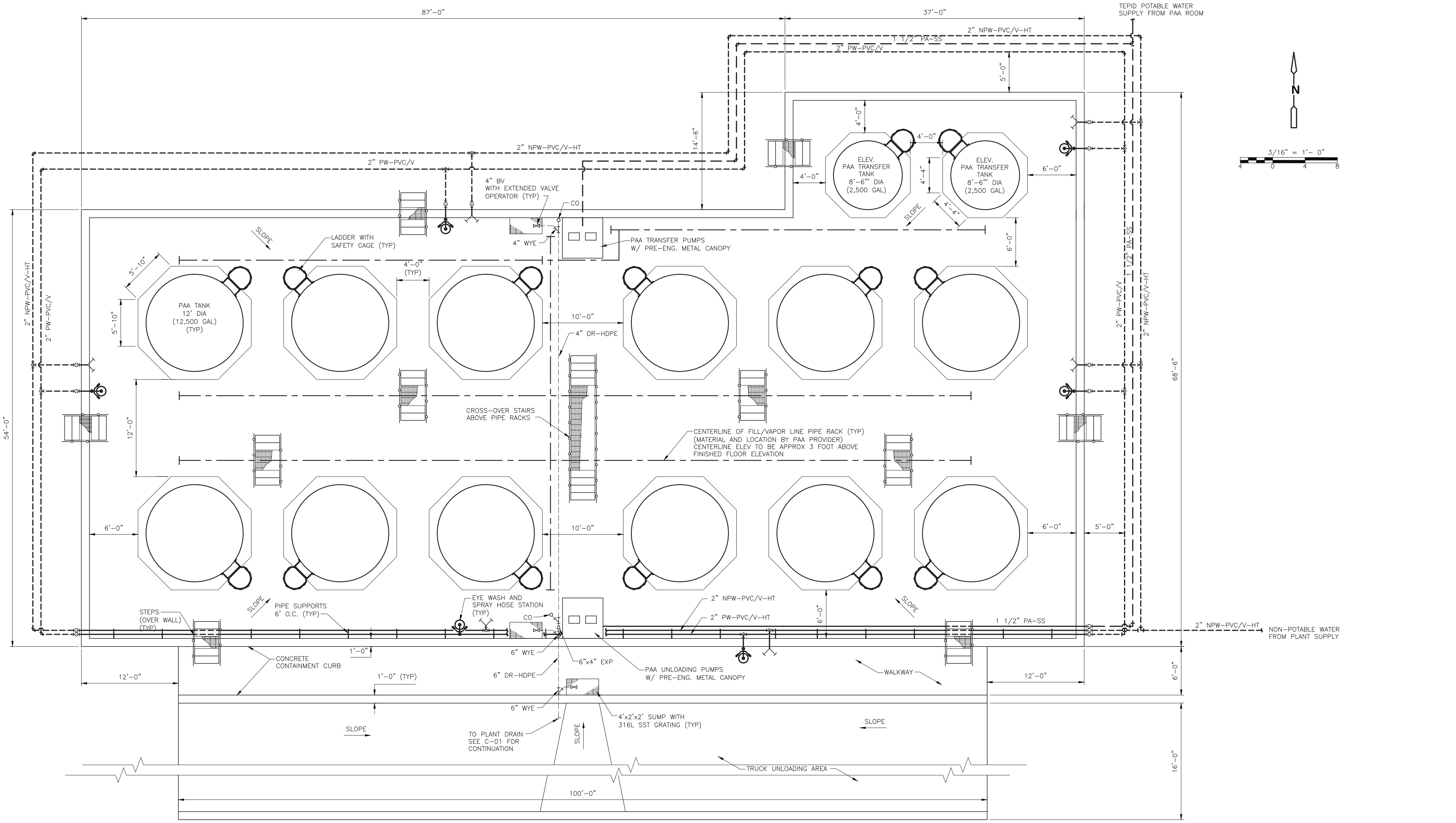
REVIEWED

DEP. CITY ENGINEER DATE CITY ENGINEER DATE

30% SUBMITTAL - NOT FOR CONSTRUCTION

CDM Smith
210 25TH Avenue North
Suite 1102
Nashville, TN 37203
Tel: (615) 3203161

MAYNARD C. STILES WWTP



NOTES:

1. PUMP SKIDS SHALL BE DESIGNED AND SUPPLIED BY THE PAA PROVIDER. PUMP PAD SIZE AS REQUIRED BY PAA PROVIDER.
2. ABOVE GROUND PW PIPING WILL BE HEAT TRACED AND INSULATED.
3. CHEMICAL STORAGE TANK DESIGN BY PAA PROVIDER. NUMBER AND LOCATION OF TANK TIE DOWNS BY PAA PROVIDER.
4. CONTAINMENT FLOOR, CURBS, TRENCHES, SUMPS AND EQUIPMENT PADS SHALL BE COATED WITH CHEMICALLY RESISTANT COATING.
5. REFER TO PAA PROVIDER DESIGN PACKAGE FOR PIPE ROUTING, PIPE SUPPORT DESIGN, VALVE TYPE AND LOCATIONS OF CHEMICAL LINES.
6. GRATING OVER SUMPS SHALL BE PROVIDED IN SECTIONS TO ALLOW EASY REMOVAL.

CHEMICAL STORAGE AREA

PLAN

3/16" = 1'-0"

REVISION		
ITEM NO.	DESCRIPTION of CHANGE	APPROVAL DATE

CDM Smith

210 25TH Avenue North
Suite 1102
Nashville, TN 37203
Tel: (615) 3203161

MAYNARD C. STILES WWTP

DISINFECTION IMPROVEMENTS

DRAWING: **M-01** SHEET X OF XX

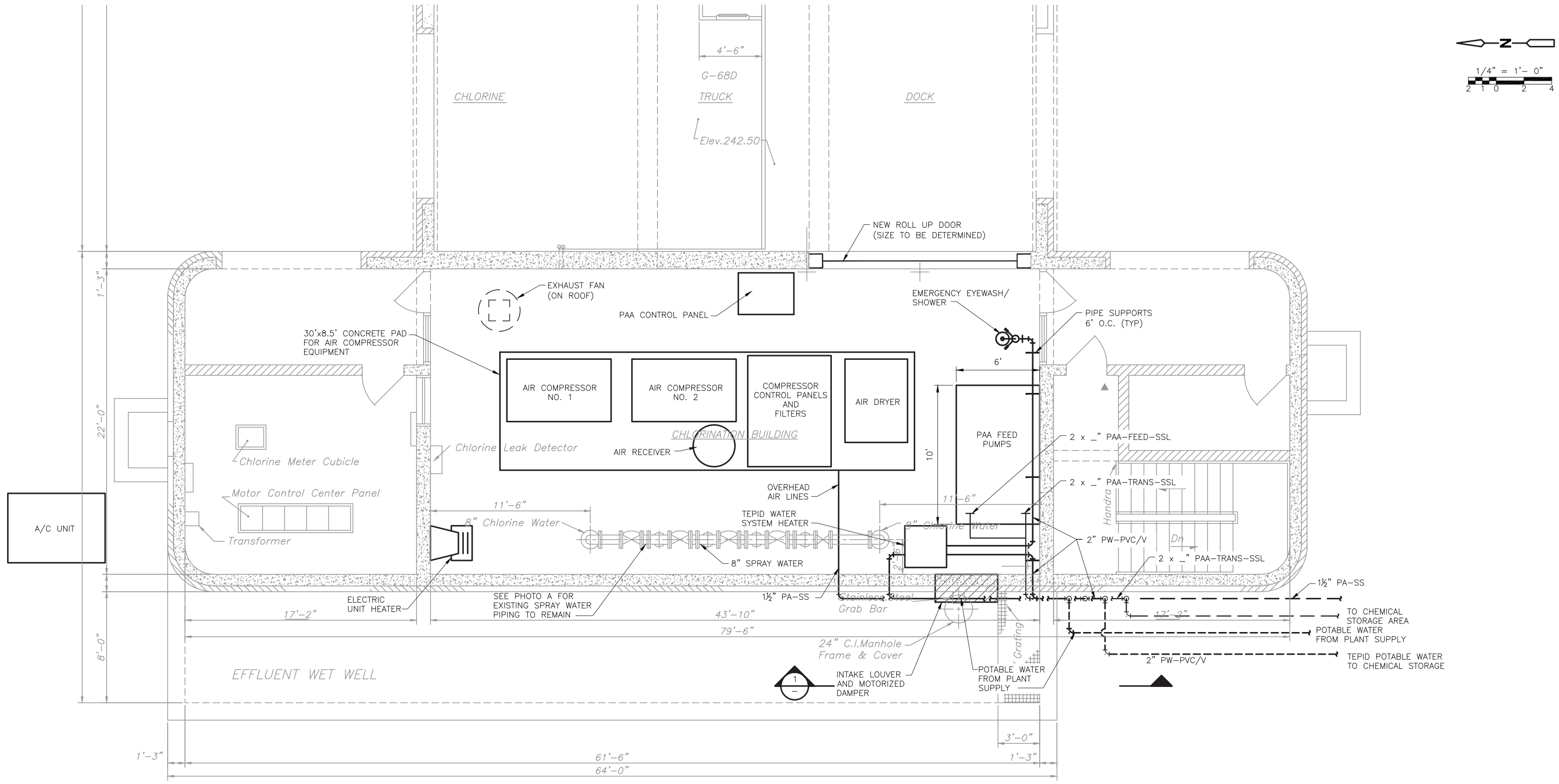
MEMPHIS LIGHT GAS AND WATER

CHEMICAL STORAGE TANK CONTAINMENT AREA PLAN

MEMPHIS, TN

SURVEY	DATE	BOOK	
DRAWN BY CEZEAUX	DATE SEP 2014	SCALE 3/16"=1'-0"	
DESIGN BY GRISSOM	DATE SEP 2014	PROJECT 6016-83104	
	REVIEWED		
DEP. CITY ENGINEER	DATE	CITY ENGINEER	DATE

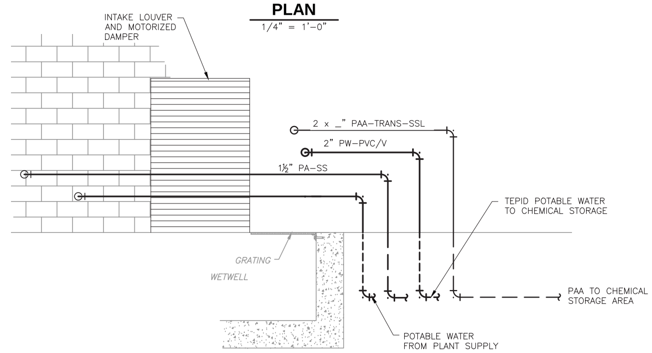
60% SUBMITTAL - NOT FOR CONSTRUCTION



PAA ROOM MODIFICATIONS

PLAN

1/4" = 1'-0"



SECTION 1

1/4" = 1'-0"

PHOTO A

EXISTING SPRAY WATER PIPING

NOTES:

1. FLOOR SHALL BE COATED WITH CHEMICALLY RESISTANT COATING.
2. REFER TO PAA PROVIDER DESIGN PACKAGE FOR PIPE ROUTING, PIPE SUPPORT DESIGN, AND LOCATIONS OF CHEMICAL LINES.
3. PUMP SKIDS, CONTROL PANEL, AND CHEMICAL LINES SHALL BE DESIGNED AND SUPPLIED BY PAA PROVIDER.
4. ABOVE GROUND PW PIPING SHALL BE HEAT TRACED AND INSULATED.

REVISION		
ITEM NO.	DESCRIPTION of CHANGE	APPROVAL DATE

CDM Smith
210 25TH Avenue North
Suite 1102
Nashville, TN 37203
Tel: (615) 3203161

MAYNARD C. STILES WWTP

DISINFECTION IMPROVEMENTS

DRAWING: **M-02** SHEET X OF XX

MEMPHIS LIGHT GAS AND WATER

PAA BUILDING PLAN

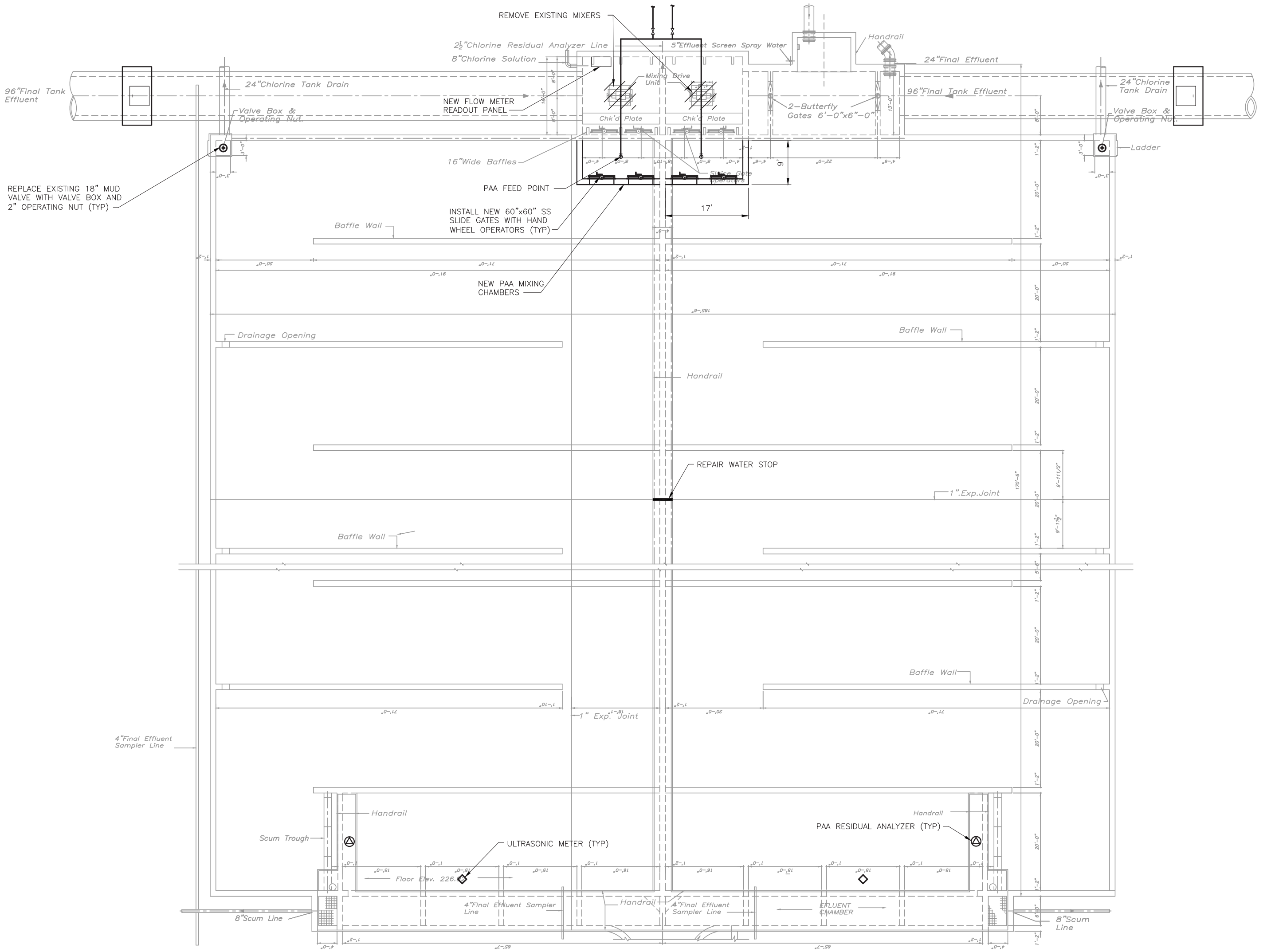
MEMPHIS, TN

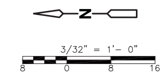
SURVEY ____ DATE ____ BOOK ____
DRAWN BY CEZEAUX DATE SEP 2014 SCALE 1/4"=1'-0"
DESIGN BY GRISSOM DATE SEP 2014 PROJECT 6016-83104

REVIEWED

DEP. CITY ENGINEER DATE CITY ENGINEER DATE

60% SUBMITTAL - NOT FOR CONSTRUCTION





LEGEND

TO BE DEMOLISHED

NOTES:

1. ALL NEW VALVES AND APPURTENANCES SHALL BE CONSTRUCTED OF PASSIVATED STAINLESS STEEL.
2. ENTIRE CONTACT BASIN SHALL BE COATED WITH CHEMICALLY RESISTANT COATING AFTER STRUCTURAL REPAIRS ARE COMPLETE.
3. CONCRETE DAMAGE SHALL BE REPAIRED PER THE STRUCTURAL DRAWINGS AND SPECIFICATIONS AS DIRECTED BY THE ENGINEER.

CONTACT TANK MODIFICATIONS

PLAN

3/32" = 1'-0"

REVISION		
ITEM NO.	DESCRIPTION of CHANGE	APPROVAL DATE

CDM Smith
210 25TH Avenue North
Suite 1102
Nashville, TN 37203
Tel: (615) 3203161

MAYNARD C. STILES WWTP

DISINFECTION IMPROVEMENTS

DRAWING: **M-03** SHEET X OF XX

MEMPHIS LIGHT GAS AND WATER

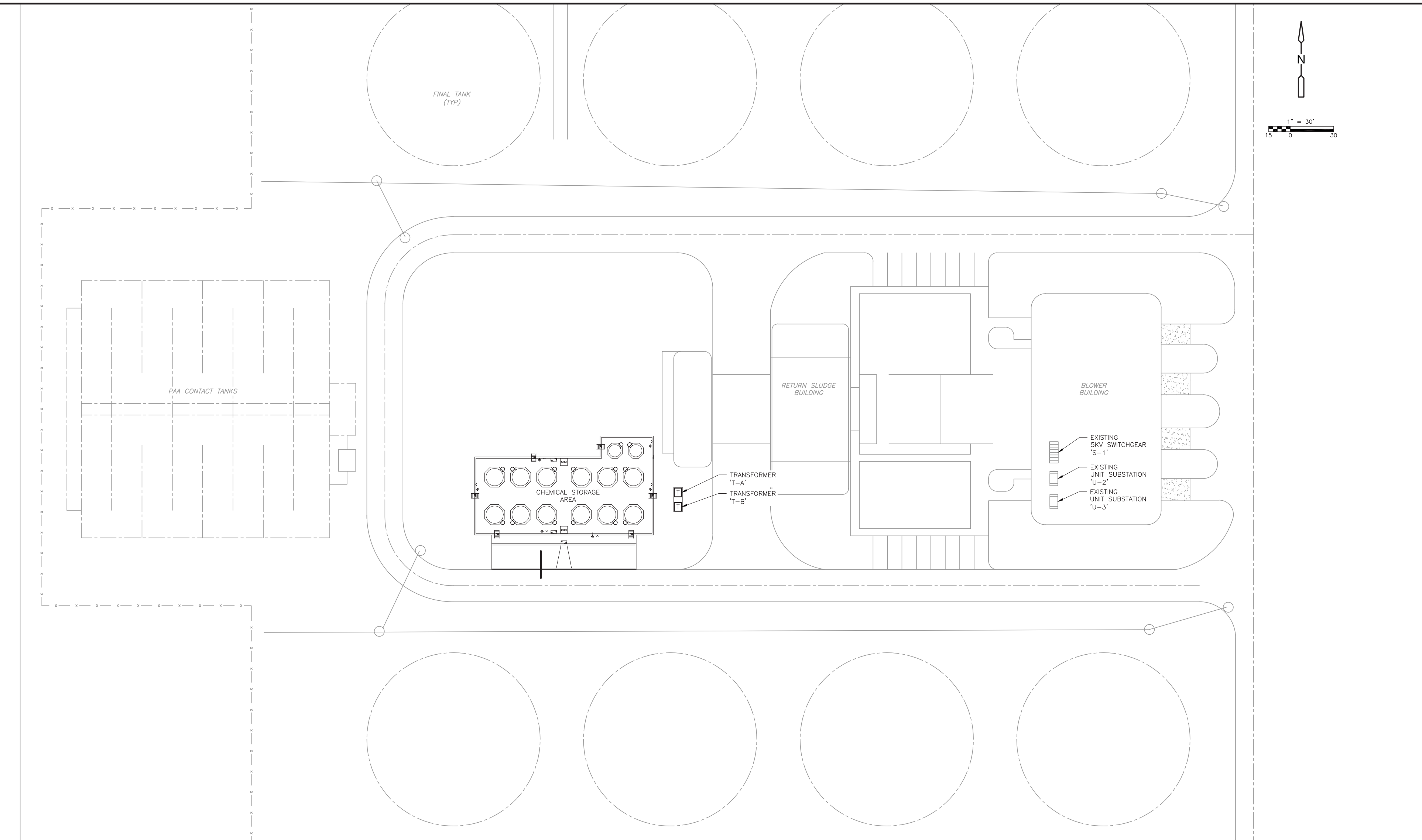
CONTACT TANK MODIFICATIONS

MEMPHIS, TN

SURVEY ____ DATE ____ BOOK ____
DRAWN BY CEZEAUX DATE SEP 2014 SCALE 3/32"=1'-0"
DESIGN BY GRISSOM DATE SEP 2014 PROJECT 6016-83104
REVIEWED

DEP. CITY ENGINEER DATE CITY ENGINEER DATE

60% SUBMITTAL - NOT FOR CONSTRUCTION



REVISION		
ITEM NO.	DESCRIPTION of CHANGE	APPROVAL DATE

CDM Smith

210 25TH Avenue North
Suite 1102
Nashville, TN 37203
Tel: (615) 3203161

MAYNARD C. STILES WWTP

DISINFECTION IMPROVEMENTS

DRAWING: E-01 SHEET X OF XX

MEMPHIS LIGHT GAS AND WATER

ELECTRICAL SITE PLAN

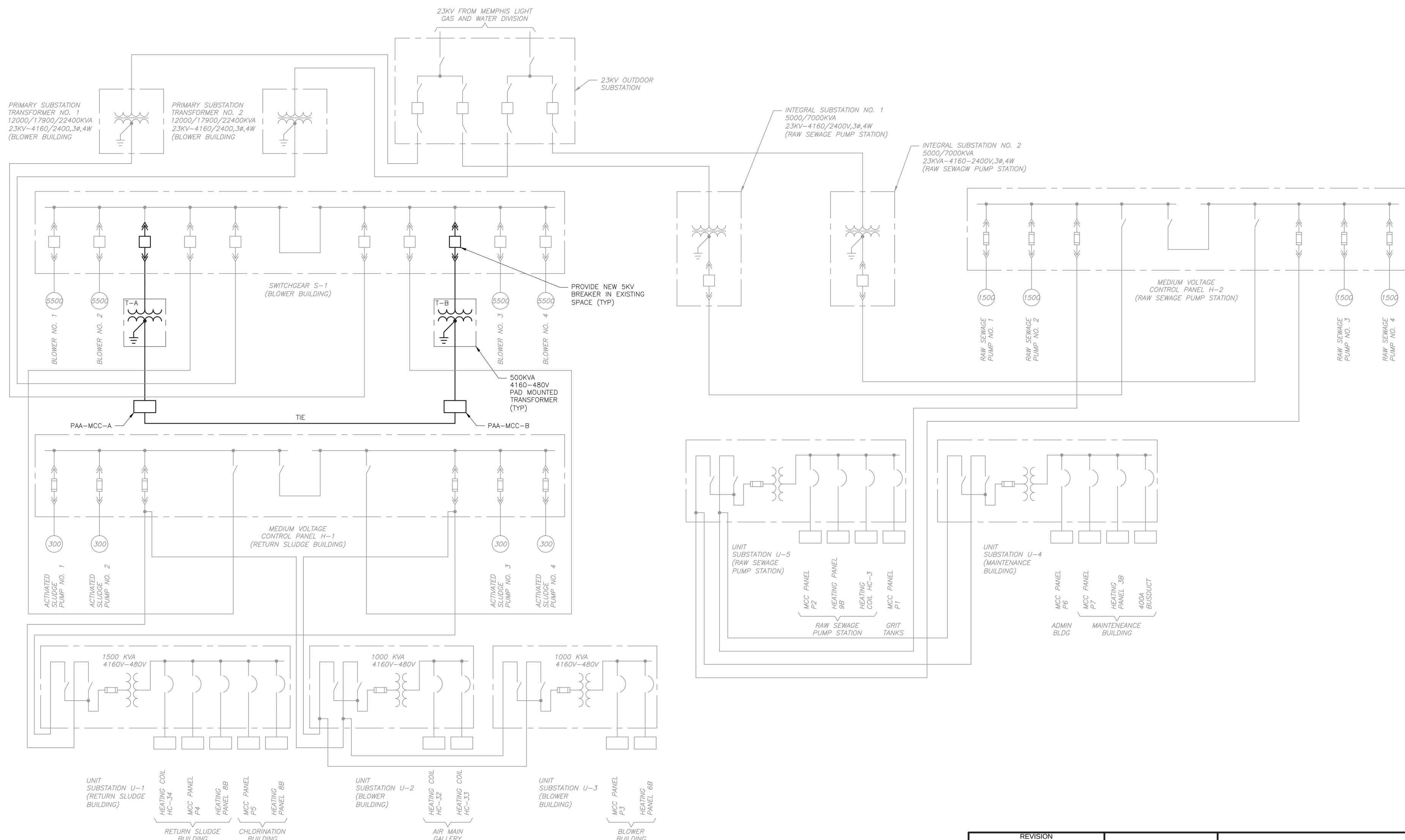
MEMPHIS, TN

SURVEY ____ DATE ____ BOOK ____
DRAWN BY RHC DATE JAN 2014 SCALE ____
DESIGN BY PRC DATE JAN 2014 PROJECT 6016-83104

REVIEWED

DEP. CITY ENGINEER DATE CITY ENGINEER DATE

30% SUBMITTAL - NOT FOR CONSTRUCTION



REVISION		
ITEM NO.	DESCRIPTION of CHANGE	APPROVAL DATE

CDM Smith
210 25TH Avenue North
Suite 1102
Nashville, TN 37203
Tel: (615) 3203161

MAYNARD C. STILES WWTP

DISINFECTION IMPROVEMENTS

DRAWING: E-02 SHEET X OF XX

MEMPHIS LIGHT GAS AND WATER

OVERALL ONE LINE POWER DIAGRAM

MEMPHIS, TN

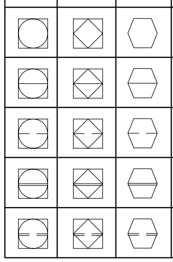
SURVEY ______ DATE ______ BOOK ______
DRAWN BY RHC DATE JAN 2014 SCALE ______
DESIGN BY PRC DATE JAN 2014 PROJECT 6016-83104

REVIEWED

DEP. CITY ENGINEER ______ DATE ______ CITY ENGINEER ______ DATE ______

30% SUBMITTAL - NOT FOR CONSTRUCTION

GENERAL INSTRUMENT OR FUNCTION SYMBOLS

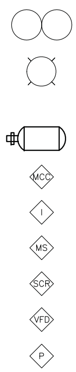


SHARED DISPLAY/ SHARED CONTROL				
PRIMARY CHOICE	SECONDARY CHOICE	COMPUTER SOFTWARE	DISCRETE	LOCATION AND ACCESSIBILITY
				FIELD MOUNTED AND NORMALLY OPERATOR ACCESSIBLE
				PRIMARY CONTROL PANEL MOUNTED AND NORMALLY OPERATOR ACCESSIBLE
				PRIMARY CONTROL PANEL MOUNTED AND NOT NORMALLY OPERATOR ACCESSIBLE
				SECONDARY CONTROL PANEL MOUNTED AND NORMALLY OPERATOR ACCESSIBLE
				SECONDARY CONTROL PANEL MOUNTED AND NOT NORMALLY OPERATOR ACCESSIBLE

INSTRUMENTS SHARING COMMON HOUSING

PILOT LIGHT

MISCELLANEOUS SYMBOLS



MOTOR

INDICATES INTERLOCK OR LOGIC IN A MOTOR CONTROL CENTER

INDICATES GENERAL OR MISCELLANEOUS HARDWIRED INTERLOCK

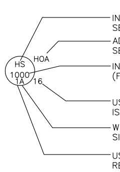
MOTOR STARTER

SILICONE CONTROL RECTIFIER

VARIABLE FREQUENCY DRIVE

PURGE OR FLUSHING DEVICE

TYPICAL TAG NUMBERS & DESIGNATION



- INSTRUMENT TYPE SEE "INSTRUMENTATION FUNCTION CODE" TABLE
- ADDITIONAL INSTRUMENT IDENTIFICATION SEE "HAND SWITCH ABBREVIATIONS"
- INSTRUMENT IDENTIFICATION (FIRST TWO DIGITS DENOTE ASSOCIATED AREA)
- USED TO DENOTE THE DIVISION THE INSTRUMENT IS SUPPLIED UNDER OR IF THE INSTRUMENT IS EXISTING OR FUTURE.
- WHEN USED, LETTER DISTINGUISHES BETWEEN MULTIPLE, SIMILAR DEVICES.
- USED WHEN MULTIPLE TRAINS ARE USED AND REPRESENTS THE TRAIN NUMBER.

HAND SWITCH ABBREVIATIONS

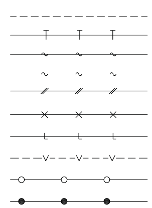
AO = AUTO/OFF
AM = AUTO/MANUAL
CM = COMPUTER/MANUAL
CL = COMPUTER/LOCAL
E-STOP = EMERGENCY STOP
FR = FORWARD/REVERSE
FOR = FORWARD/OFF/REVERSE
FS = FAST SLOW
FOS = FAST/OFF/SLOW
HOA = HAND/OFF/AUTO
LLS = LEAD/LAG/STANDBY
LOC = LOCAL/OFF/COMPUTER
LOR = LOCAL/OFF/REMOTE
LOS = LOCKOUT/STOP
LA = LOCAL/AUTO
LR = LOCAL/REMOTE
OC = OPEN/CLOSE
OCA = OPEN/CLOSE/AUTO
OO = ON/OFF
OOA = ON/OFF/AUTO
OSC = OPEN/STOP/CLOSE
RSL = RAISE/STOP/LOWER
SS = START/STOP
SOR = START/OFF/RESET

INSTRUMENTATION FUNCTION CODE

	FIRST LETTERS		SUCCEEDING LETTERS		
	COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5
	MEASURED/INITIATING VARIABLE	VARIABLE MODIFIER	READOUT/PASSIVE FUNCTION	OUTPUT/ACTIVE FUNCTION	FUNCTION MODIFIER
A	ANALYSIS		ALARM		
B	BURNER, COMBUSTION		USER'S CHOICE	USER'S CHOICE	USER'S CHOICE
C	USER'S CHOICE			CONTROL	CLOSED
D	USER'S CHOICE	DIFFERENCE, DIFFERENTIAL			DEVIATION
E	VOLTAGE		SENSOR, PRIMARY ELEMENT		
F	FLOW, FLOW RATE	RATIO			
G	USER'S CHOICE		GLASS, GAUGE, VIEWING DEVICE		
H	HAND				HIGH
I	CURRENT		INDICATE		
J	POWER		SCAN		
K	TIME, SCHEDULE	TIME RATE OF CHANGE		CONTROL STATION	
L	LEVEL		LIGHT		LOW
M	MOISTURE				MIDDLE, INTERMEDIATE
N	USER'S CHOICE		USER'S CHOICE	USER'S CHOICE	USER'S CHOICE
O	USER'S CHOICE		ORIFICE, RESTRICTION		OPEN
P	PRESSURE		POINT (TEST CONNECTION)		
Q	QUANTITY	INTEGRATE, TOTALIZE	INTEGRATE, TOTALIZE		
R	RADIATION		RECORD		RUN
S	SPEED, FREQUENCY	SAFETY		SWITCH	STOP
T	TEMPERATURE			TRANSMIT	
U	MULTIVARIABLE		MULTIFUNCTION	MULTIFUNCTION	
V	VIBRATION, MECHANICAL, ANALYSIS			VALVE, DAMPER, LOUVER	
W	WEIGHT, FORCE		WELL, PROBE		
X	UNCLASSIFIED (1)	X-AXIS	ACCESSORY DEVICES, UNCLASSIFIED (1)	UNCLASSIFIED (1)	UNCLASSIFIED (1)
Y	EVENT, STATE, PRESENCE	Y-AXIS		AUXILIARY DEVICES	
Z	POSITION, DIMENSION	Z-AXIS, SAFETY INSTRUMENT SYSTEM		DRIVER, ACTUATOR, UNCLASSIFIED, FINAL CONTROL ELEMENT	

TABLE NOTES:
(1) WHEN USED SYMBOL OR SIGNAL LINE IS ANNOTATED.

INSTRUMENT LINE SYMBOLS

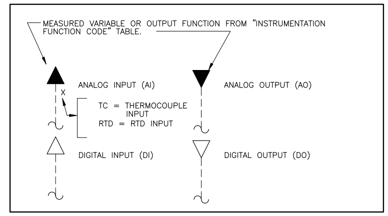


ELECTRICAL SIGNAL
TELEPHONE SIGNAL
ELECTROMAGNETIC OR SONIC SIGNAL (GUIDED)
ELECTROMAGNETIC OR SONIC SIGNAL (UNGUIDED)
PNEUMATIC SIGNAL
CAPILLARY TUBE
HYDRAULIC SUPPLY
VENDOR SUPPLIED CABLE
COMMUNICATION LINK – COPPER (HARDWIRED)
COMMUNICATION LINK – FIBER OPTICS

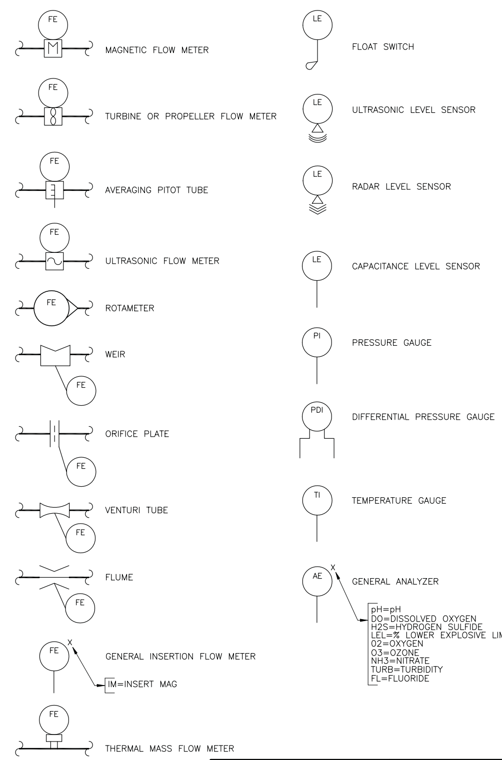
ELECTRICAL / AIR SOURCES

UPS— UPS POWERED ELECTRICAL SOURCE
ES— ELECTRICAL SOURCE
IA INSTRUMENT AIR SOURCE

I/O SIGNALS



PRIMARY ELEMENTS



GENERAL NOTES

1. THIS LEGEND APPLIES TO P&IDS ONLY AND MAY DIFFER FROM LEGENDS FOR OTHER SHEETS.

2. IN GENERAL THIS LEGEND SHEET AND THE P&IDS ARE BASED ON THE INTERNATIONAL SOCIETY OF AUTOMATION (ISA) STANDARDS FOR PRACTICES FOR INSTRUMENTATION. SOME MODIFICATIONS, ADDITIONS AND ALTERATIONS HAVE BEEN MADE AS REQUIRED TO ACCOMODATE PROJECT REQUIREMENTS.

3. SOME PROCESS ITEMS SUCH AS EQUIPMENT ISOLATION VALVES, BYPASS LINES, ETC., WHICH ARE NOT CRITICAL FOR AN UNDERSTANDING OF THE INSTRUMENTATION FUNCTIONS ARE NOT SHOWN ON THE P&IDS.

4. SEE ELECTRICAL AND MECHANICAL SHEETS AND SPECIFICATIONS FOR ADDITIONAL CONTROL AND INTERLOCK REQUIREMENTS.

5. LIGHTER WEIGHT LINES, SHOWN AS ———, INDICATE EQUIPMENT, INSTRUMENTS OR PIPING THAT ARE EXISTING. WEIGHTED LINES, SHOWN AS ——— OR HEAVIER ———, INDICATE EQUIPMENT, INSTRUMENTS OR PIPING THAT ARE NEW. DASHED WEIGHTED LINES, SHOWN AS — – – –, INDICATED EQUIPMENT, INSTRUMENTS OR PIPING THAT ARE GROUPED AS A PACKAGE.

GENERAL ABBREVIATIONS

AI	ANALOG IN
AO	ANALOG OUT
CPU	CENTRAL PROCESSOR UNIT
DI	DIGITAL OR DISCRETE INPUT
DO	DIGITAL OUTPUT
FC	FAIL CLOSED
FO	FAIL OPEN OR FIBER OPTIC
HMI	HUMAN MACHINE INTERFACE
MCC	MOTOR CONTROL CENTER
NC	NORMALLY CLOSED
NPW	NON-POTABLE WATER
NO	NORMALLY OPEN
PLC	PROGRAMMABLE LOGIC CONTROLLER
PW	PLANT WATER
RIO	REMOTE INPUT/OUTPUT
UPS	UNINTERRUPTIBLE POWER SUPPLY
VFD	VARIABLE FREQUENCY DRIVE

REVISION		
ITEM NO.	DESCRIPTION of CHANGE	APPROVAL DATE

CDM Smith
210 25TH Avenue North
Suite 1102
Nashville, TN 37203
Tel: (615) 3203161

MAYNARD C. STILES WWTP

DISINFECTION IMPROVEMENTS

DRAWING: I-1 SHEET X OF XX

MEMPHIS LIGHT GAS AND WATER

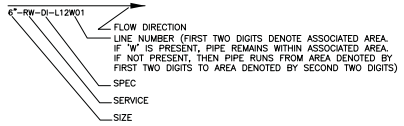
INSTRUMENTATION LEGEND - I

MEMPHIS, TN

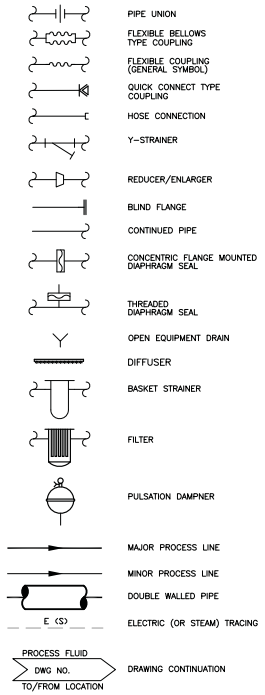
SURVEY ____ DATE ____ BOOK ____
DRAWN BY APK DATE SEP 2014 SCALE ____
DESIGN BY SEM DATE SEP 2014 PROJECT 6016-83104
REVIEWED
DEP. CITY ENGINEER DATE CITY ENGINEER DATE

60% SUBMITTAL - NOT FOR CONSTRUCTION

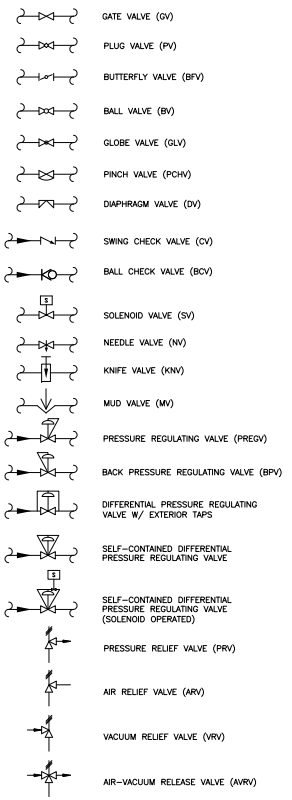
TYPICAL PIPE TAG NUMBERS & DESIGNATION



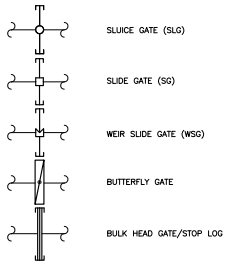
PIPE LINE SYMBOLS



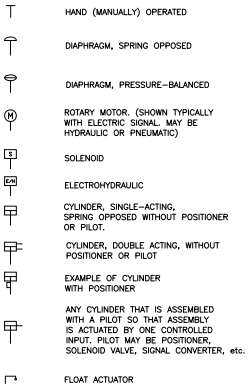
VALVE SYMBOLS



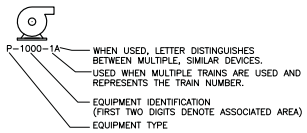
GATE SYMBOLS



VALVE ACTUATORS

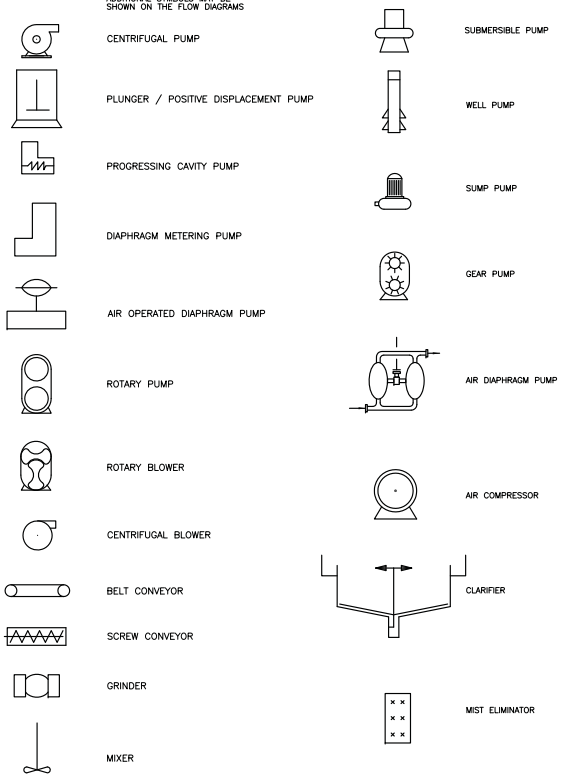


TYPICAL EQUIPMENT TAG NUMBERS & DESIGNATION



PROCESS EQUIPMENT

PARTIAL LIST
ADDITIONAL SYMBOLS MAY BE SHOWN ON THE FLOW DIAGRAMS



GENERAL NOTES

1. REFER TO SHEET I-1 FOR ADDITIONAL NOTES

REVISION		
ITEM NO.	DESCRIPTION of CHANGE	APPROVAL DATE

CDM Smith
210 25TH Avenue North
Suite 1102
Nashville, TN 37203
Tel: (615) 3203161

MAYNARD C. STILES WWTP

DISINFECTION IMPROVEMENTS

DRAWING: I-2 SHEET X OF XX

MEMPHIS LIGHT GAS AND WATER

INSTRUMENTATION LEGEND - II

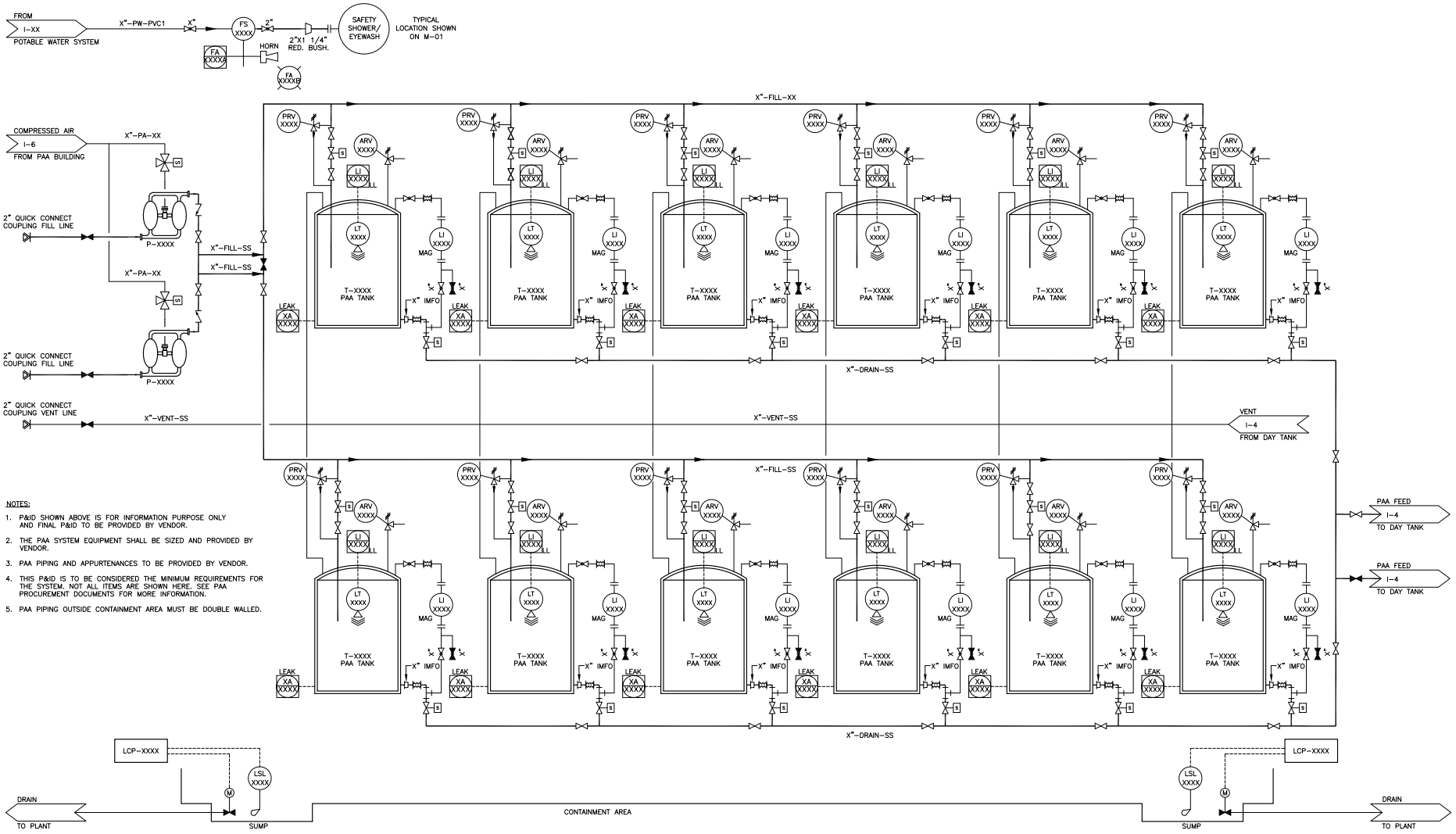
MEMPHIS, TN

SURVEY		DATE		BOOK	
DRAWN BY	APK	DATE	SEP 2014	SCALE	
DESIGN BY	SEM	DATE	SEP 2014	PROJECT	6016-83104

REVIEWED

DEP. CITY ENGINEER DATE CITY ENGINEER DATE

60% SUBMITTAL - NOT FOR CONSTRUCTION



NOTES:

1. P&ID SHOWN ABOVE IS FOR INFORMATION PURPOSE ONLY AND FINAL P&ID TO BE PROVIDED BY VENDOR.
2. THE PAA SYSTEM EQUIPMENT SHALL BE SIZED AND PROVIDED BY VENDOR.
3. PAA PIPING AND APPURTENANCES TO BE PROVIDED BY VENDOR.
4. THIS P&ID IS TO BE CONSIDERED THE MINIMUM REQUIREMENTS FOR THE SYSTEM. NOT ALL ITEMS ARE SHOWN HERE. SEE PAA PROCUREMENT DOCUMENTS FOR MORE INFORMATION.
5. PAA PIPING OUTSIDE CONTAINMENT AREA MUST BE DOUBLE WALLED.

REVISION

ITEM NO.	DESCRIPTION of CHANGE	APPROVAL DATE

CDM Smith
210 25TH Avenue North
Suite 1102
Nashville, TN 37203
Tel: (615) 3203161

MAYNARD C. STILES WWTP

DISINFECTION IMPROVEMENTS

DRAWING: I-3 SHEET X OF XX

MEMPHIS LIGHT GAS AND WATER

PERACETIC ACID STORAGE SYSTEM

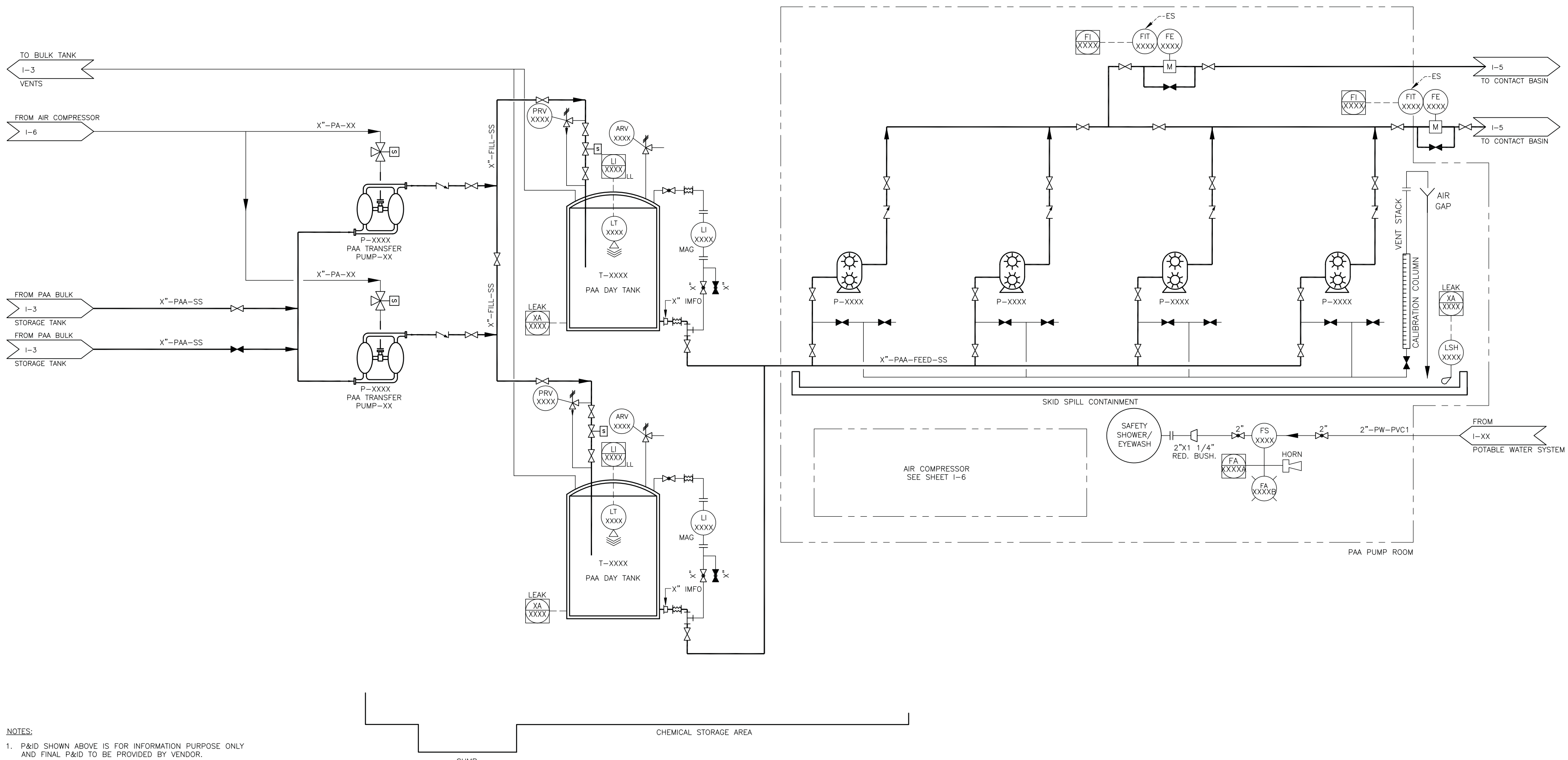
MEMPHIS, TN

SURVEY		DATE		BOOK	
DRAWN BY	APK	DATE	SEP 2014	SCALE	
DESIGN BY	SEM	DATE	SEP 2014	PROJECT	6016-83104

REVIEWED

DEP. CITY ENGINEER DATE CITY ENGINEER DATE

60% SUBMITTAL - NOT FOR CONSTRUCTION



NOTES:

1. P&ID SHOWN ABOVE IS FOR INFORMATION PURPOSE ONLY AND FINAL P&ID TO BE PROVIDED BY VENDOR.
2. THE PAA SYSTEM EQUIPMENT SHALL BE SIZED AND PROVIDED BY VENDOR.
3. PAA PIPING AND APPURTENANCES TO BE PROVIDED BY VENDOR.
4. THIS P&ID IS TO BE CONSIDERED THE MINIMUM REQUIREMENTS FOR THE SYSTEM. NOT ALL ITEMS ARE SHOWN HERE. SEE PAA PROCUREMENT DOCUMENTS FOR MORE INFORMATION.
5. PAA PIPING OUTSIDE CONTAINMENT AREA MUST BE DOUBLE WALLED.

REVISION		
ITEM NO.	DESCRIPTION of CHANGE	APPROVAL DATE

CDM Smith
210 25TH Avenue North
Suite 1102
Nashville, TN 37203
Tel: (615) 3203161

MAYNARD C. STILES WWTP

DISINFECTION IMPROVEMENTS

DRAWING: I-4 SHEET X OF XX

MEMPHIS LIGHT GAS AND WATER

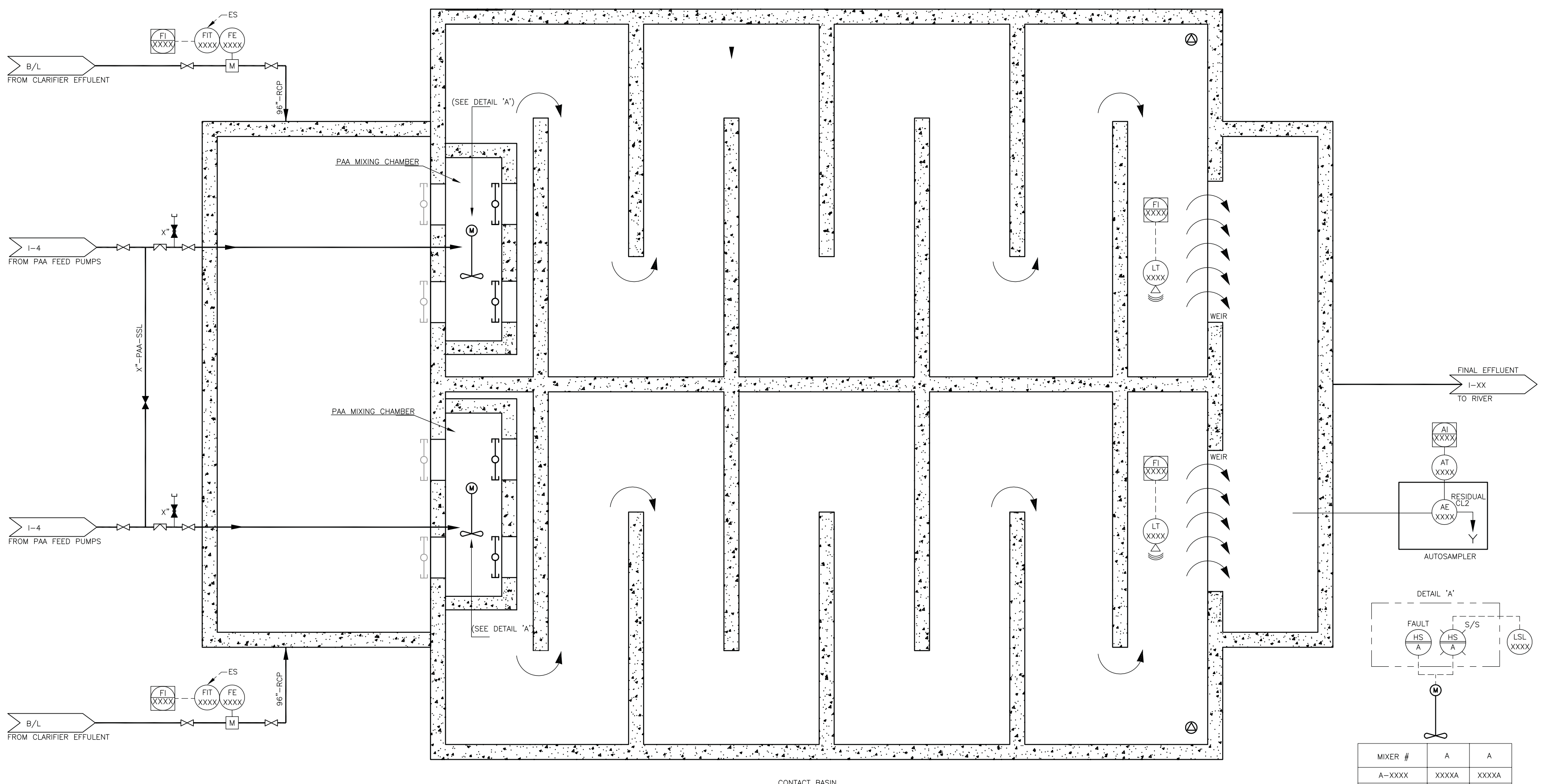
PERACETIC ACID FEED SYSTEM

MEMPHIS, TN

SURVEY ____ DATE ____ BOOK ____
DRAWN BY APK DATE SEP 2014 SCALE ____
DESIGN BY SEM DATE SEP 2014 PROJECT 6016-83104
REVIEWED

DEP. CITY ENGINEER DATE CITY ENGINEER DATE

60% SUBMITTAL - NOT FOR CONSTRUCTION



MIXER #	A	A
A-XXXX	XXXXA	XXXXA
B-XXXX	XXXXB	XXXXB

NOTES:

1. PAA PROVIDER TO PROVIDE AND INSTALL MIXER AND PAA FEED PIPING.
2. PAA PROVIDER TO SUPPLY 4 PAA ANALYZERS IN LOCATIONS IDENTIFIED WITH △.
3. PAA PIPING OUTSIDE CONTAINMENT AREA MUST BE DOUBLE WALLED.
4. PAA PROVIDED TO SUPPLY AND INSTALL CONTROL PANELS FOR MIXING UNITS. COORDINATE PAA MIXING SYSTEM CONTROLS INTEGRATION INTO PAA SCADA SYSTEM.

REVISION		
ITEM NO.	DESCRIPTION of CHANGE	APPROVAL DATE

CDM Smith
210 25TH Avenue North
Suite 1102
Nashville, TN 37203
Tel: (615) 3203161

MAYNARD C. STILES WWTP

DISINFECTION IMPROVEMENTS

DRAWING: I-5 SHEET X OF XX

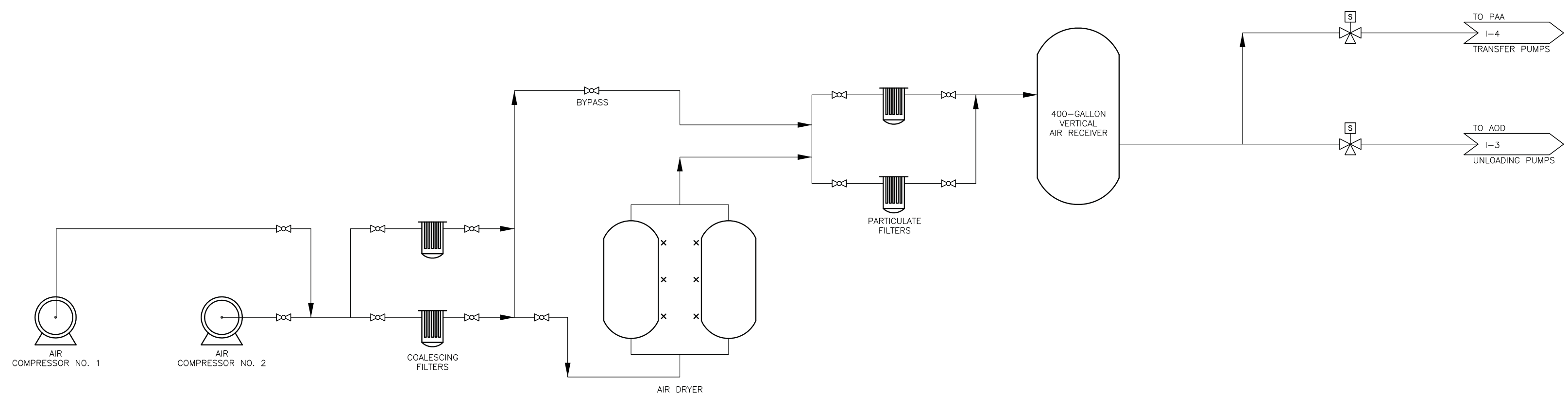
MEMPHIS LIGHT GAS AND WATER

PERACETIC ACID CONTACT BASIN

MEMPHIS, TN

SURVEY ____ DATE ____ BOOK ____
DRAWN BY APK DATE SEP 2014 SCALE ____
DESIGN BY SEM DATE SEP 2014 PROJECT 6016-83104
REVIEWED
DEP. CITY ENGINEER DATE CITY ENGINEER DATE

60% SUBMITTAL - NOT FOR CONSTRUCTION



NOTES:

1. AIR COMPRESSOR PACKAGE TO BE PROVIDED AND SIZED BY PAA PROVIDER.
2. AIR COMPRESSOR PACKAGE IS LOCATED INSIDE PAA PUMP ROOM SEE SHEET I-4.

REVISION		
ITEM NO.	DESCRIPTION of CHANGE	APPROVAL DATE

CDM Smith
210 25TH Avenue North
Suite 1102
Nashville, TN 37203
Tel: (615) 3203161

MAYNARD C. STILES WWTP

DISINFECTION IMPROVEMENTS

DRAWING: I-6 SHEET X OF XX

MEMPHIS LIGHT GAS AND WATER

AIR COMPRESSOR SYSTEM

MEMPHIS, TN

SURVEY ____ DATE ____ BOOK ____
DRAWN BY APK DATE SEP 2014 SCALE ____
DESIGN BY SEM DATE SEP 2014 PROJECT 6016-83104

REVIEWED

DEP. CITY ENGINEER DATE CITY ENGINEER DATE

60% SUBMITTAL - NOT FOR CONSTRUCTION

Appendix D

Structural Review Study

Inspection Report

North Sewage Treatment Plant, Memphis TN

A visual structural inspection of the existing Chlorine Contact Tank at the North Sewage Treatment Plant was performed on November 5, 2013 for the North half of the structure and on November 19, 2013 for the South half of the structure. The purpose of the visual inspection was to assess the overall condition of the structure and provide recommendations for repairs required to extend the useful life of the structure.

The inspection included visual observations, concrete sounding using a hammer, tape measure to verify dimensions, as well as taking photographs.

Existing Chlorine Contact Tank

The original design drawings for the structure indicate the structure was designed in 1972. The structure is 186'-5" (North-South) by 170'-6" (East-West) with a depth that varies from 15'-1" to 15'-11". The hydrostatic walls are shown to be 1'-2" thick, the interior baffle walls are 12" thick, and the base slab is 1'-4" thick under the hydrostatic walls and 12" thick everywhere else. The drawings indicate the tank was designed with 2" of concrete cover over the rebar. There is a center wall dividing the structure into a northern tank and a southern tank which can be operated independently. There is an expansion joint in each direction (North-South and East-West) splitting the structure into four quadrants. Although not indicated on the design drawings, there was physical evidence that construction joints were added to the structure when it was built. On the West side of the structure is the effluent chamber and on the East side of the structure is the mixing chamber. Both the mixing chamber and effluent chamber were in service, therefore the inside of these chambers were not inspected.

Tank Visual Inspection

The exterior, above grade portions of the walls were inspected first. The condition of the visible concrete was found to be in good to fair condition at the time of the inspection. There were several structural cracks, numerous hairline cracks on the walls and walkway slabs. The exposed surface of the concrete was worn with exposed aggregate in many areas.

The expansion joints in each direction were in poor shape and the concrete in the area of the expansion joint was spalled. The waterstop in the center divider wall expansion joint has failed. Water freely flowed through the joint. When observed from the South half of the structure, a piece of waterstop could be observed protruding out of the expansion joint.

The condition of the concrete walls and base slab below the normal liquid level was generally found to be in good condition at the time of the inspection. An area of spalled concrete was observed near the beam near the Northwest corner of the structure. Numerous areas with "pop outs" were observed on the base slab.

An area on the North wall adjacent to the expansion joint running North-South was observed to have exposed vertical reinforcing bars. A total of 21 bars were noted in this area. Another 4 vertical reinforcing bars were observed at the North end of the East wall. More exposed vertical and horizontal

reinforcing was observed near the influent gates in the South half of the structure as well as on the South face of the center divider wall, West of the expansion joint. Two vertical reinforcing bars were noted to be exposed on the South face of the South wall, just West of the expansion joint. Based on field measurements, it does not appear that the concrete cover of the rebar has been worn away over time, rather it appears that the rebar in these areas was not placed 2" from the face of the wall.

Vertical cracks were observed in the center divider wall, primarily near the West end of the wall. Some of these cracks extended through the width of the wall.

Guardrail was missing on part of the effluent outfall box as well as on the mixing chamber. There were approximately 40 guardrail post connections with missing bolts, broken welds, or deteriorated base plates.

The ladder in the Southeast corner of the structure has been bent and damaged.

There are pressure relief (flap) valves installed near the base of the walls. There were approximately 13 valves with missing caps. The valves were not leaking water into the tank indicating either the groundwater elevation was low or that the valves are frozen in the closed position.

Repar and Rehabilitation Recommendations

Process structures such as the chlorine contact chamber are typically designed for a 50 year life expectancy. Although this structure is now more than 40 years old, it is still in fairly good condition. With some repair and rehabilitation the structure's useful life can be extended well beyond the 50 year design life expectancy.

Exposed Reinforcing

Maintaining and protecting the rebar should be considered to be a very high priority. If the rebar is compromised, the strength of the structure is significantly weakened. In order to prevent any reduction in strength, the areas with exposed rebar are recommended to have the following repairs:

- Thoroughly clean exposed rebar of all rust/corrosion.
- If more than half of the rebar is exposed, chip back concrete 1.5" on each side.
- Apply one component cementitious repair product designed specifically for vertical repairs such as SikaRepair 223, by Sika Corp.
- Any exposed rebar with significant loss of section must be evaluated on a case by case basis to determine the appropriate method to splice new rebar to restore strength.

Non-moving Structural Cracks

Before attempting a repair on a concrete crack, it must first be determined if the crack is moving or non-moving. A rigid repair material may be used for a non-moving crack whereas a flexible material is used for moving cracks. A simple crack monitor can be placed over the cracks in question and monitored for movement over several months. Avongard makes and affordable crack monitor.

Cracks which are larger than hairline and/or extend completely through the thickness of the wall and are not moving are recommended to have the following repairs:

- Blast clean the area per the manufacturer's instructions.

- Install a high modulus, low viscosity moisture tolerant epoxy grout by gravity or injection such as Sikadur 35, Hi0Mod LV, by Sika Corp.

Moving Structural Cracks

Cracks which are larger than hairline and/or extend completely through the thickness of the wall and are moving are recommended to have the following repairs:

- Blast clean the area per the manufacturer's instructions.
- Drill injection ports on each side of the crack at a 45 degree angle to intersect the crack at the center of the wall. Install ports and flush with water per manufacturer's instructions.
- Inject low viscosity, hydrophilic, expanding polyurethane chemical grout such as SikaFix HH, by Sika Corp. Remove ports after installation.

Expansion Joints

All existing expansion joints are recommended to have the following repairs:

- Clean concrete surface on each side of existing expansion joint.
- Install Sikadur Combiflex system along entire length of expansion joint. The Combiflex system is a hypalon sheeting epoxy grouted to each side of the expansion joint forming a water tight seal.

For the leaking expansion joint, prior to installing the Combiflex system, first stop the leaking by following the procedure listed above for moving cracks.

Guardrail Posts and Ladders

Missing, loose and broken guardrail posts are dangerous and represent a safety to concern to all staff working around the structures. Caution tape alerting staff to weak or damaged posts should be installed as soon as possible. Long term, permanent fixes include:

- Install expansion joints in base plates with missing bolts.
- For all post connections with broken welds or damaged base plates, remove existing base plate and install new base using expansion bolts into the concrete.
- Install new guardrail matching the existing in areas with missing guardrail.
- Repair or replace damaged ladder at Southeast corner.

Coating

In order to protect the concrete from further attack and degredation, the addition of a protective coating to the interior concrete surfaces is highly recommended. There are an endless array of possible coatings for structures such as these. Two possible options are listed below for consideration.

- Option 1: Apply an acid resistant reinforced calcium aluminate cementitious product such as Raven 705CA, by raven linings. This would be applied to the interior of the tank as well as all exposed concrete to protect and preserve the concrete.

- Option 2: Apply an acid resistant 100% solid novolac epoxy coating such as Protecto-Coat 100XT by Dudick Inc. This coating would be applied to the interior concrete surfaces of the structure. Additionally, the tops of walls and walkways would need to be protected with a cementitious resurfacer such as Meadow Patch T2 by W.R. Meadows.

Summary

The chlorine contact chamber is in good condition considering it's age. The structure needs certain repairs and rehabilitation to protect and extend it's useful life. Protecting the reinforcing steel by repairing the areas with exposed rebar is critical to maintaining the strength of the structure. Additionally, a coating added to protect the concrete from further attack is highly recommended. Repairing damaged guardrail connections and providing missing guardrail are also necessary to provide a safe working environment.

Inspection Photographs

Photograph 1

Crack in top of wall at Southwest corner of effluent outfall box.

Photograph 2

Crack in top of wall at Northwest corner of effluent outfall box.

Deteriorated expansion joint and spalled concrete at top of wall near Northwest corner.

Photograph 3

Crack and worn surface with exposed aggregate at effluent box.

Photograph 4

Photograph 5

Expansion joint on North wall with spalled concrete, exposed waterstop and previous repair attempt.

Photograph 6

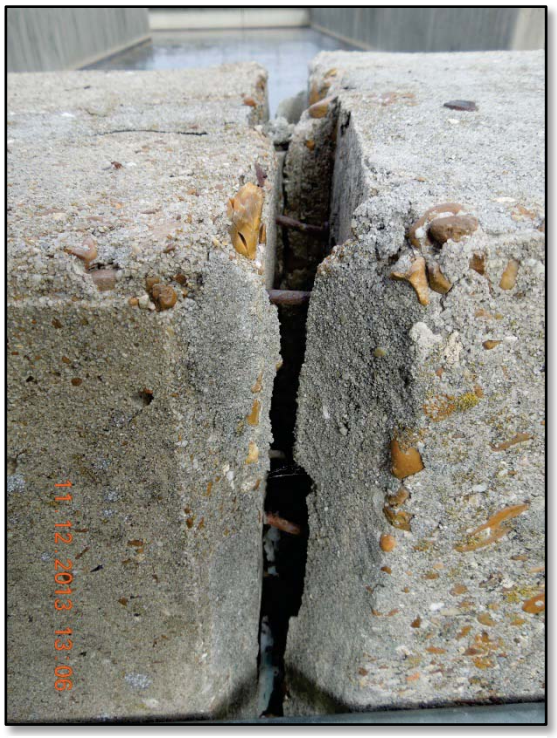
Horizontal construction joint between wall and top slab at East wall of mixing chamber

Photograph 7

Missing Guardrail on East wall of mixing chamber

Photograph 8

Damaged ladder on Southeast corner.



Photograph 9

Damaged expansion joint along South wall.

Photograph 10

Two vertical rebar exposed on exterior face of South wall.

Photograph 11

Typical guardrail post with broken welded connection

Photograph 12

Typical guardrail post with deteriorated base plate.

Photograph 13

Spalled concrete at under side of beam in North half of structure.

Photograph 14

Typical condition of pressure relief (flap) valve near base of wall.

Photograph 15

Leaking expansion joint in center divider wall, as seen from the North.

Photograph 16

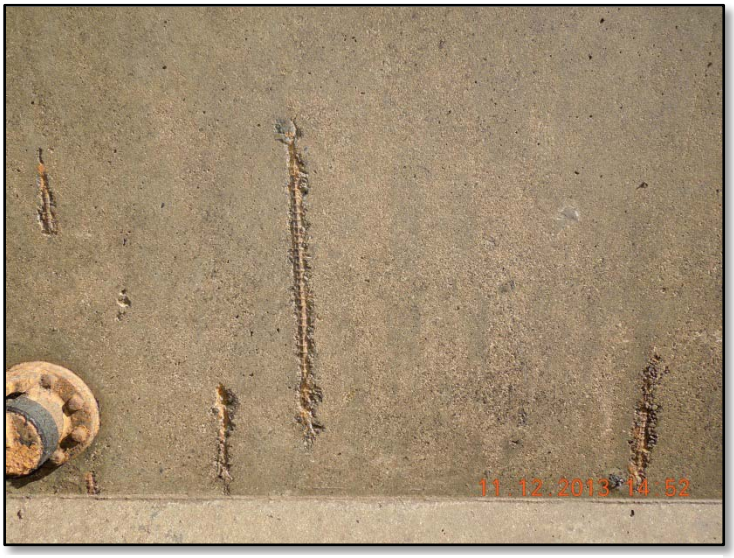
Exposed vertical reinforcing in North wall at expansion joint.

Photograph 17

Close up of exposed vertical reinforcing in North wall near expansion joint.

Photograph 18

Typical pressure relief (flap) valve with missing cover.



Photograph 19

Exposed vertical reinforcing at North end of East wall (near sump)

Photograph 20

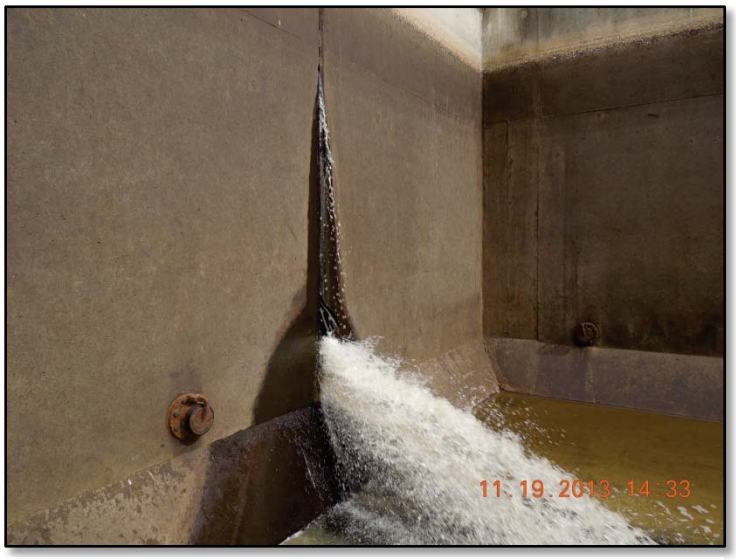
Northern most gate in East wall with minor leaking.

Photograph 21

Cracks at West end of center divider wall as seen from the South half of the structure.

Photograph 22

Minor surface cracking in base slab of South half of structure



Photograph 23

Leaking expansion joint in center divider wall as seen from the South side of the structure.

Photograph 24

Close up of leaking expansion joint as seen from the South. Note waterstop protruding from joint.

Photograph 25

Exposed horizontal and vertical reinforcing on East wall, near southern most gate at mixing chamber.

Photograph 26

Close up of exposed vertical reinforcing on East wall, near southern most gate at mixing chamber.

Inspection Report

North Sewage Treatment Plant, Memphis TN

A visual structural inspection of the existing Chlorine building at the North Sewage Treatment Plant was performed on November 5, 2013. The purpose of the visual inspection was to assess the overall condition of the structure and provide recommendations for repairs required to extend the useful life of the structure.

The inspection included visual observations, concrete sounding using a hammer, tape measure to verify dimensions, as well as taking photographs.

Existing Chlorine Building

The original design drawings for the structure indicate the structure was designed in 1972. The structure is 82'-0"" (North-South) by 24'-6" (East-West). The structure has two levels, the lower level foundation is constructed at elevation 225.50', the ground floor slab is at elevation 242.50, and the roof slab is at elevation 258.5'. The below grade walls are constructed of cast in place concrete and are indicated to be 1'-3" thick. The above grade walls are constructed of 10" cast in place concrete with a 4" brick veneer. The foundation is constructed of a 12" thick cast in place concrete mat foundation supported by 40 ton capacity piles located under the perimeter concrete walls. The ground floor slab is a 10" thick cast in place concrete slab with cast in place concrete beams. The roof slab is a 7" thick cast in place concrete slab with cast in place concrete roof beams. The lower level is connected to the lower level of the Sludge Pump building.

Building Visual Inspection

The reinforced concrete walls, slabs and brick veneer were found to be in very good condition at the time of the inspection. There were no signs of cracks or structural distress noted at the time of the inspection.

The roof was not inspected, however there were no visible signs of leakage into the building at the time of the inspection.

Repair and Rehabilitation Recommendations

The recommendations for the structure are primarily aesthetic in nature.

- Repair wall air conditioning unit in the Northeast corner of the structure and re-paint wall to protect from moisture damage.
- Monitor brick and repair any damage to the brick and/or mortar quickly to avoid costly repairs in the future.
- If roofing membrane is more than 20 years old, consider replacing the membrane to avoid leaking onto new equipment.

Modifications to the structure (i.e. adding new doors, windows, louvers) or increasing the loads on the structure (i.e. more equipment and/or heavier equipment) will require a structural review and analysis of the structure. The addition of openings will require a new wind analysis to determine

the wind classification of the modified structure (enclosed, partially enclosed, etc.). Wind loads will be calculated based on the modified structure and any modifications will be required to meet the current building code requirements. Additionally, if the stresses on any existing structural member are increased by more than 5%, a seismic analysis will need to be performed and strengthening of the affected members to meet the current seismic loading requirements will be required.

Summary

The chlorine building is in very good condition. The repairs and preventative maintenance items listed are recommended to protect and extend its useful life.

Appendix E

Opinion of Probable Construction Cost

City of Memphis
WWTP Disinfection
Opinion of Probable Construction Cost, Jan 2014, 30% Design

Project name	WWTP Disinfection
ENR 20 City CCI	9551.58
Notes	This is an Opinion of Probable Construction Cost only, as defined by the documents provided at the level of design indicated above. CDM Smith has no control over the cost of labor, materials, equipment, or services furnished, over schedules, over contractor's methods of determining prices, competitive bidding (at least 3 each - both prime bidders and major subcontractors), market conditions or negotiating terms. CDM Smith does not guarantee that this opinion will not vary from actual cost, or contractor's bids. There are not any costs provided for: Change Orders, Design Engineering, Construction Oversight, Client Costs, Finance or Funding Costs, Legal Fees, Land Acquisition or temporary/permanent Easements, Operations, or any other costs associated with this project that are not specifically part of the bidding contractor's proposed scope. This OPCC shall remain vaild for 120 days. Beyond this date, CDM Constructors should be notified of design changes. The estimate will also be reviewed to reflect current market conditions. Assumptions: No rock excavation is required. Only nominal dewatering is needed. No consideration for contaminated soils or hazardous materials is included (i.e. asbestos, lead, etc). Based on a normal 40 hour work week with no overtime.

Spreadsheet Level	Takeoff Quantity	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Amount
05 Sitework							
02000 Sitework							
02000.0600 Relocate Storm Drain Inlet	3 ea	497	342		492		1,332
02000 Sitework		497	342		492		1,332
02220 Demolition							
02220.0600 Demo Existing Curb & Gutters	1,000 lf	1,233	156	329	2,506		4,224
02220 Demolition		1,233	156	329	2,506		4,224
02500 Utility Services							
02500.0600 6' dia. Manholes	2 ea	3,094	8,934	36	1,871	630	14,564
02500 Utility Services		3,094	8,934	36	1,871	630	14,564
02600 Drainage & Containment							
02600.0600 New Curb & Gutter	1,500 lf			31,500			31,500
02600 Drainage & Containment				31,500			31,500
02700 Base/Ballast/Pavements & Appurtenances							
02700.0600 New Concrete Paving	712 sy	2,268	24,110		1,102		27,480
02700 Base/Ballast/Pavements & Appurtenances		2,268	24,110		1,102		27,480
15000 PROCESS MECHANICAL							
15000.0600 Relocate Existing 24" Tank Drain Line & Effluent Line	540 lf	27,937	126,646	1,667	21,360		177,610
15000.0601 Relocate Existing 5" Spray Wash	180 lf	4,315	3,753	218	1,745		10,031
15000 PROCESS MECHANICAL		32,252	130,400	1,885	23,105		187,641
05 Sitework		**39,345**	**163,941**	**33,749**	**29,076**	**630**	**266,741**
10 PAA Storage Area							
02300 Earthwork							
02300.0600 Clear & Grub	1,185 cy	2,527			9,904		12,431
02300 Earthwork		2,527			9,904		12,431
03000 CONCRETE							
03000.0600 24" PAA Containment Slab & Truck Loading Area	707 cy	106,817	211,883	2,773	1,585	1,655	324,713
03000.0601 18" Tall PAA Containment Walls	22 cy	18,947	12,654	354	212	51	32,218
03000.0602 18" Tall Concrete Tank Pads	136 cy	39,979	46,817	2,668	487	319	90,271
03000 CONCRETE		165,743	271,355	5,795	2,285	2,025	447,202
05500 Metal Fabrications							
05500.0600 Access Stairs	6 ea	2,761	11,358		848		14,967
05500.0601 SS Grating	25 sf	181	2,132				2,312
05500 Metal Fabrications		2,942	13,490		848		17,279
09900 Painting & Coatings							
09900.0600 Chemical Coating	10,150 sf	14,616	27,480				42,095
09900 Painting & Coatings		14,616	27,480				42,095
11200 Water Treatment Equipment							
11200.0600 PAA Transfer & Unloading Pump Installation	2 ea	2,995			2,041	1,944	6,980
11200 Water Treatment Equipment		2,995			2,041	1,944	6,980
13200 Tanks							
13200.0600 Tank Installation	14 ea	51,239			12,423	1,882	65,544
13200 Tanks		51,239			12,423	1,882	65,544
15000 PROCESS MECHANICAL							
15000.0602 2" PW-PVC/HT	500 lf	7,587	6,894	485	3,387		18,354
15000.0605 PAA Piping Allowance - Installation Only	1 ls			50,000			50,000
15000.0606 PAA 4" Drain Line	25 lf	1,383	1,142	28	371		2,924
15000.0607 1-1/2" Process Air Line	300 lf	3,527	4,766		6	4	8,304
15000 PROCESS MECHANICAL		12,497	12,802	50,514	3,765	4	79,582
15400 Plumbing							
15400.0600 Emergency Eyewash Station	6 ea	1,244	1,404				2,648
15400.0601 Spray Hose Station	6 ea	1,555	1,591				3,147
15400 Plumbing		2,800	2,995				5,795
10 PAA Storage Area		**255,358**	**328,122**	**56,308**	**31,266**	**5,854**	**676,909**
15 PAA Room Mods							
03000 CONCRETE							

Spreadsheet Level	Takeoff Quantity	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Amount
03000.0603 6" Tall Concrete Equipment Pad	6 cy	1,778	2,082	119	22	14	4,014
03000.0606 Concrete Columns	1 cy	1,314	1,452				2,766
03000 CONCRETE		3,092	3,534	119	22	14	6,780
08000 DOORS & WINDOWS							
08000.0600 New Roll-up Door	1 ea	280	10,435				10,716
08000.0601 New Man Doors	3 ea	1,275	5,520				6,795
08000 DOORS & WINDOWS		1,555	15,955				17,511
09900 Painting & Coatings							
09900.0600 Chemical Coating	1,000 sf	1,440	2,707				4,147
09900 Painting & Coatings		1,440	2,707				4,147
11000 EQUIPMENT							
11000.0600 Air Compressor - Installation Only	2 ea	631					631
11000 EQUIPMENT		631					631
15000 PROCESS MECHANICAL							
15000.0605 PAA Piping Allowance - Installation Only	1 ls			15,000			15,000
15000 PROCESS MECHANICAL				15,000			15,000
15400 Plumbing							
15400.0600 Emergency Eyewash Station	1 ea	207	234				441
15400 Plumbing		207	234				441
15500 HVAC							
15500.0600 HVAC	1 ls	1,352	4,044	7,200	1,200		13,796
15500 HVAC		1,352	4,044	7,200	1,200		13,796
15 PAA Room Mods		**8,277**	**26,475**	**22,319**	**1,222**	**14**	**58,307**
20 Contact Tank Mods							
02000 Sitework							
02000.0601 Cofferdam for Slide Gate Installation	1 ls			50,000			50,000
02000 Sitework				50,000			50,000
03000 CONCRETE							
03000.0604 Repair Water Stop	1 ls	3,145	53				3,198
03000.0605 Repair Concrete	1 ls			20,000			20,000
03000 CONCRETE		3,145	53	20,000			23,198
09900 Painting & Coatings							
09900.0600 Chemical Coating	85,000 sf	122,397	230,127				352,523
09900 Painting & Coatings		122,397	230,127				352,523
11200 Water Treatment Equipment							
11200.0601 Mixer Allowance - Install Only	2 ea			5,000			5,000
11200 Water Treatment Equipment				5,000			5,000
11282 Slide Gates							
11282.0600 60" x 60" Slide Gates	4 ea	9,186	120,000		11,390	2,280	142,856
11282 Slide Gates		9,186	120,000		11,390	2,280	142,856
15000 PROCESS MECHANICAL							
15000.0603 New 18" Mud Valves & Valve Box	2 ea	4,566	20,645			24	25,235
15000.0605 PAA Piping Allowance - Installation Only	1 ls			50,000			50,000
15000 PROCESS MECHANICAL		4,566	20,645	50,000		24	75,235
20 Contact Tank Mods		**139,294**	**370,824**	**125,000**	**11,390**	**2,304**	**648,812**
80 Electrical & Instrumentation							
13400 Measurement & Control Instrumentation							
13401.0110 Instrumentation & Control	1 ls	22,593	48,000	7,250		3,600	81,443
13400 Measurement & Control Instrumentation		22,593	48,000	7,250		3,600	81,443
13700 Security Access & Surveillence							
13701.0113 Site Security System	1 ls	15,830	82,302				98,132
13700 Security Access & Surveillence		15,830	82,302				98,132
16090 Service & Distribution							
16091.0101 Motor Control Center	2 ea	7,732			3,098		10,830
16090 Service & Distribution		7,732			3,098		10,830
16100 Site Power							

Spreadsheet Level	Takeoff Quantity	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Amount
16102.0100 Medium Voltage Systems	4 ea	3,228	237,103				240,331
16100 Site Power		3,228	237,103				240,331
16130 Feeders							
16131.0102 MV Feeder: New 5kv Breaker to New 500kva TFMR	800 lf	30,934	57,388	120			88,443
16131.0103 Feeder: New 500kva TFMR to PAA-MCC-A,-B	800 lf	58,963	121,494	240			180,697
16131.0104 Feeder: PAA-MCC to Packaged Air Compressor	150 lf	3,324	4,523	45			7,892
16132.0111 I&C Feeder: PLC to Tank Level Instruments	750 lf	13,134	13,513	185			26,832
16132.0112 I&C Feeder: PLC to Flow Meters	600 lf	7,670	8,480	148			16,298
16133.0114 Site Security System Fiber-optic Branch	1,500 lf	26,215	14,316		865		41,397
16130 Feeders		140,240	219,715	738	865		361,558
16150 Connections							
16151.0106 Equipment Connect & Feed: PAA Pumps	4 ea	26,917	81,778	180			108,874
16151.0107 Equipment Connect & Feed: Acid Mixers	2 ea	25,818	83,551	200			109,568
16151.0108 Equipment Connect & Feed: PAA Transfer Pumps	4 ea	11,726	41,488	148			53,362
16151.0109 Equipment Connect & Feed: Air Dryer	1 ea	2,680	8,618	37			11,335
16150 Connections		67,140	215,434	565			283,140
80 Electrical & Instrumentation		**256,763**	**802,554**	**8,553**	**3,963**	**3,600**	**1,075,434**

Estimate Totals

Description	Amount	Totals	Hours	Rate
Labor	699,038		16,448 hrs	
Material	1,691,917			
Subcontract	245,929			
Equipment	76,916		660 hrs	
Other	12,402			
Subtotal Direct Cost	**2,726,202**	**2,726,202**		
Building Permits(% total cost)	47,854			1.00 %
Sales Tax (Permanent Mat'l)				
Sales Tax (Non-Permanent)	5,955			8.00 %
Bldr's Risk Ins (% total cost)	9,571			0.20 %
Gen Liab Ins (% total cost)	47,854			1.00 %
GC Bonds (% total cost)	71,781			1.50 %
Subtotal Prior to OH&P	**183,015**	**2,909,217**		
GC General Conditions	233,344			10.00 %
Contractor Total OH&P	574,247			12.00 %
Subtotal with OH&P	**807,591**	**3,716,808**		
Construction Contingency	929,201			25.00 %
Total Cost at:	**929,201**	**4,646,009**		
Escalation to Mid Point Constr	139,380			3.00 %
Based on 3% per year				
	139,380	**4,785,389**		
Total		***4,785,389***		

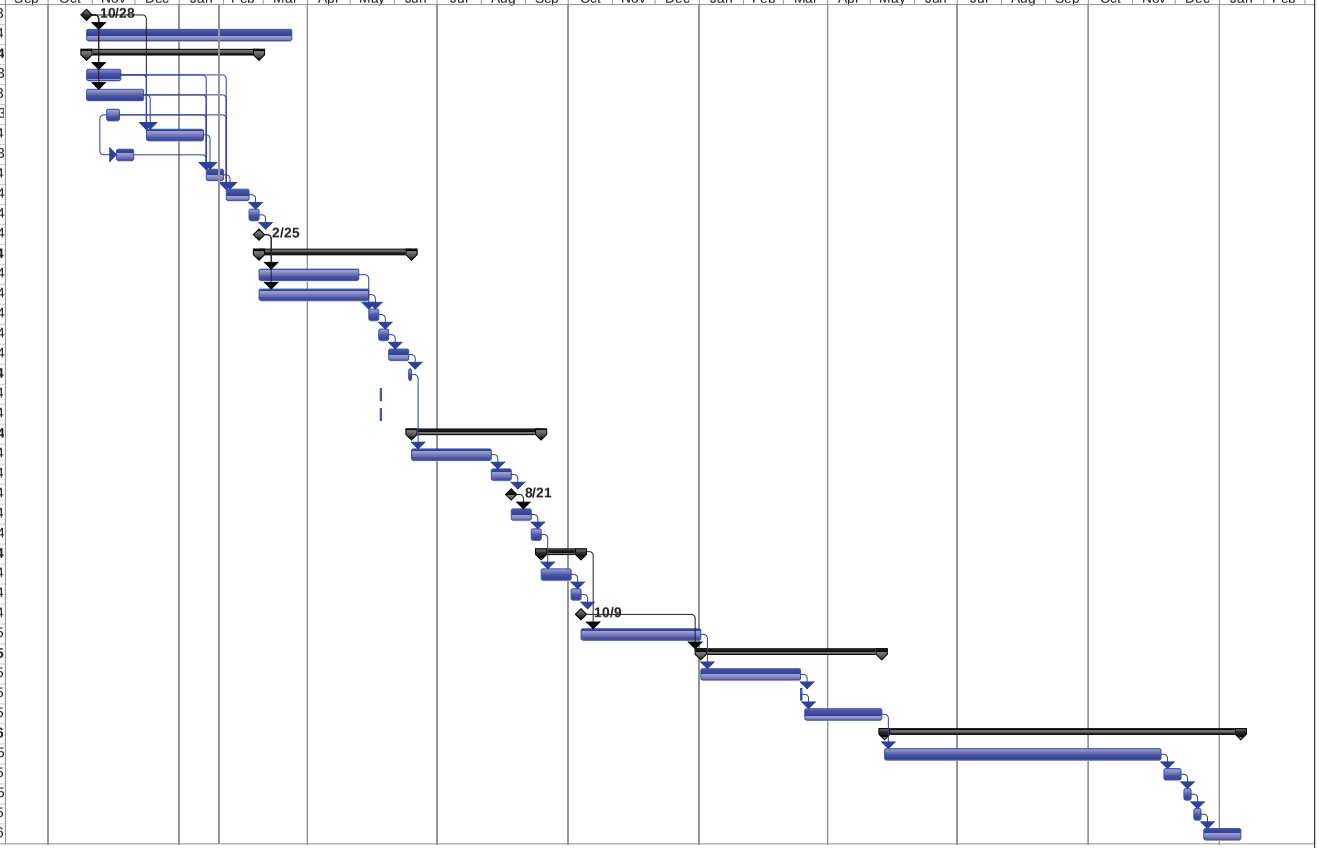
"This Opinion of Probable Construction Cost is produced in accordance with CDM Smith's Firmwide Quality policies and best practices as described in CDM Smith's Estimating Manual Dated 01/03/12 Section 10 titled Quality Control. I hereby attest that the Cost Estimating policies and procedures were followed in preparation of the Opinion of Probable Cost"

Lead Estimator initials - DN/CB Date 1/30/2014

Appendix F

Project Schedule

ID	Task Name	Duration	Start	Finish
1	Start Project	0 days	Mon 10/28/13	Mon 10/28/13
2	Permitting (TBD)	104 days	Mon 10/28/13	Thu 3/20/14
3	**30% Design**	**87 days**	**Mon 10/28/13**	**Tue 2/25/14**
4	Investigate existing basins/structures	18 days	Mon 10/28/13	Wed 11/20/13
5	Process Mechanical Design	30 days	Mon 10/28/13	Fri 12/6/13
6	Electrical Review/DN requirements	7 days	Mon 11/11/13	Tue 11/19/13
7	Civil/site and utility plan	30 days	Mon 12/9/13	Fri 1/17/14
8	Architectural concept	10 days	Mon 11/18/13	Fri 11/29/13
9	Internal Review	10 days	Mon 1/20/14	Fri 1/31/14
10	City review	12 days	Mon 2/3/14	Tue 2/18/14
11	Address City comments	5 days	Wed 2/19/14	Tue 2/25/14
12	Submit final PDR	0 days	Tue 2/25/14	Tue 2/25/14
13	**60% Design**	**77 days**	**Wed 2/26/14**	**Thu 6/12/14**
14	PAA Vendor Contract Negotiation	50 days	Wed 2/26/14	Tue 5/6/14
15	Detailed Design Development	55 days	Wed 2/26/14	Tue 5/13/14
16	Technical Review	5 days	Wed 5/14/14	Tue 5/20/14
17	Address technical review comments	5 days	Wed 5/21/14	Tue 5/27/14
18	City Review	10 days	Wed 5/28/14	Tue 6/10/14
19	City Review Workshop	**2 days**	**Wed 6/11/14**	**Thu 6/12/14**
20	Building Permit Review Meeting	1 day	Thu 5/22/14	Thu 5/22/14
21	TDEC Status Meeting	1 day	Thu 5/22/14	Thu 5/22/14
22	**90% Design**	**65 days**	**Fri 6/13/14**	**Thu 9/11/14**
23	Detailed Design Development	40 days	Fri 6/13/14	Thu 8/7/14
24	Final cross check	10 days	Fri 8/8/14	Thu 8/21/14
25	Submit to City	0 days	Thu 8/21/14	Thu 8/21/14
26	City Review	10 days	Fri 8/22/14	Thu 9/4/14
27	Address City comments	5 days	Fri 9/5/14	Thu 9/11/14
28	**100% Design**	**20 days**	**Fri 9/12/14**	**Thu 10/9/14**
29	Detailed Design Development	15 days	Fri 9/12/14	Thu 10/2/14
30	Final production check	5 days	Fri 10/3/14	Thu 10/9/14
31	Final submittal to City	0 days	Thu 10/9/14	Thu 10/9/14
32	Permit Review	60 days	Fri 10/10/14	Thu 1/1/15
33	**Advertise for Bids**	**91 days**	**Fri 1/2/15**	**Fri 5/8/15**
34	Bid Advertisement	50 days	Fri 1/2/15	Thu 3/12/15
35	Bid Opening	1 day	Fri 3/13/15	Fri 3/13/15
36	Bid Review and Award	40 days	Mon 3/16/15	Fri 5/8/15
37	**Construction**	**180 days**	**Mon 5/11/15**	**Fri 1/15/16**
38	Construction	140 days	Mon 5/11/15	Fri 11/20/15
39	Testing	10 days	Mon 11/23/15	Fri 12/4/15
40	Start Up	5 days	Mon 12/7/15	Fri 12/11/15
41	Substantial Completion	5 days	Mon 12/14/15	Fri 12/18/15
42	Final Completion	20 days	Mon 12/21/15	Fri 1/15/16



Project: Stiles Project Schedule
Date: Wed 1/29/14

Task	Project Summary	Inactive Milestone	Manual Summary Rollup	Progress
Split	External Tasks	Inactive Summary	Manual Summary	Deadline
Milestone	External Milestone	Manual Task	Start-only	
Summary	Inactive Task	Duration-only	Finish-only	

CDM Smith

cdmsmith.com